(6) INVESTIGATION OF PERFORMANCE OF CONCRETE AND CONCRETING MATERIALS EXPOSED TO NATURAL WEATHERING

TECHNICAL REPORT NO. 6-553

June 1960

Supplements, Corrections, and Revisions
Distribution No. 15*

(11) August 1980

VOLUME 1

ACTIVE INVESTIGATIONS • Revision C

Item	Part	Section	Supplement, Correction, or Revision
1	Preface		Revised p iii, reprinted p iv, revised p v, and new p vi
2	Contents		Revised pp vii and viii
3	Conversion Factors		Revised p ix
4	I		Revised Table 1 (1 page) and reprinted Table 2 (1 page)
5	II	2	Revised sheets 9 and 10 of Table 1-TC-B
6	II	3	Revised sheet 2 of Table 1-SF
7	II	4	Revised sheet 2 of Table 1-CRMI-PB
8	II	5	Revised sheet 1 and new sheet 2 of Table 1-CERL-FC
9	II	6	Revised sheets 2 and 3 and new sheet 4 of Table 2-PR; revised sheet 2 of Table 5-PR; new sheet 4 of Table 6-PR
10	II	7	Revised Table 1-WES-FC (1 page)
11	II	8	Revised sheet 5 of Table 1-CRMI-PD; revised sheet 3 of Table 2-CRMI-PD; deleted sheet 4 (issued August 1977)

* TR 6-553 was issued in June 1960. Distributions of Supplements, Corrections, and Revisions are issued each year. This distribution, No. 15, brings the report up to date as of July 1979.

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12	II	9	Revised sheet 2 of Table 1-PQ
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20	II	17	Revised sheets 9, 10, 11, and 12 of Table 1-LTS
21	II	18	Revised Table 1-NED (1 page)
22	II	19	A new item including Key (1 page), text (1 page), Table 1 (1 page), and Table 1-CPM (1 page)
23	II	20	A new item including Key (1 page), text (1 page), Table 1 (3 pages), Table 2 (3 pages), Table 3 (3 pages), Table 4 (1 page), Table 1-CR (1 page), and Table 2-CR (2 pages)
24	II	22	New sheet 2 of Table 1-MM
25	II	25	Revised sheet 6 of Table 1-CRA
26	II	26	Revised Table 1-OD (1 page)
27	II	27	Revised sheet 2 of Tables 1-KCD and 2-KCD; revised Tables 3-KCD, 4-KCD, 5-KCD, 6-KCD, and 7-KCD (1 page each)
28	II	28	Revised Table 1-ED (1 page)
29	II	34	Revised Table 1-MCP (1 page)
30	II	35	Revised Table 2-QA (1 page)
31	II	37	Revised sheet 3 of Table 1-CAP
32	II	38	New sheet 3 of Table 1-MAWC
33	II	39	Revised sheet 3 of Table 1-CT
34	II	--	Revised Plate 2

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PREFACE

The establishment of exposure stations, and the conduct of programs of investigation relative to the durability of concrete exposed to natural weathering have been authorized from time to time by the Office, Chief of Engineers. The initial installation of concrete specimens at an exposure station was made at Treat Island, Maine, in 1936 by the Concrete Laboratory of the Passamaquoddy Tidal Power Project. In 1939 the Office, Chief of Engineers, authorized the Central Concrete Laboratory, North Atlantic Division, to develop data relative to the durability of concrete exposed to severe weathering. Under this authorization specimens were prepared and installed at exposure stations in Maine, Florida, and New York. In 1946, the Office, Chief of Engineers, directed the Concrete Research Division (now Concrete Technology Division, Structures Laboratory) of the U. S. Army Engineer Waterways Experiment Station (WES) (successor to the Central Concrete Laboratory) to continue the work in connection with these exposure stations. Further authority is contained in multiple letter of the Office, Chief of Engineers, dated 14 September 1948, subject, "Civil Works Investigations of Office, Chief of Engineers," Item CW-604-Concrete "Continuation of Permanent Exposure Stations." Additional authorizations have been provided since that time for the making and installing of specific specimens at these exposure stations. Installation and testing of specimens at the Florida station was discontinued in November 1971.

Results of these various investigations have been reported from time to time in the reports listed below.

1. Corps of Engineers, Central Concrete Laboratory, Cement Durability Program, First Interim Report, June 1942.
2. _____, Concrete Research, Laboratory Studies of Concrete Containing Air-Entraining Admixtures, Second Interim Report, Part I, July 1945.

(Reprinted August 1980)

3. Waterways Experiment Station, Concrete Research, Third Interim Report, Durability of Concrete Exposed to Natural Weathering, Technical Memorandum No. 6-226, August 1947.

4. _____, Concrete Research, Third Interim Report, Supplement No. 1, Durability of Concrete Exposed to Natural Weathering, Technical Memorandum No. 6-226, June 1950.

5. _____, Investigation of Durability of Concrete Exposed to Natural Weathering, Report No. 5, Summary of Results 1936-1953, Technical Memorandum No. 6-226, May 1954.

6. _____, Cement Durability Program, Long-Term Field Exposure of Concrete Columns, Technical Report C-72-2, August 1972.

7. Roshore, E. C. and Houston, B. J., Investigation of Plastic and Rubber-Based Coatings Used in Lieu of Rubbed Finishes on Formed Concrete Surfaces, sponsored by the Assistant Secretary of the Army (R&D), Department of the Army; Miscellaneous Paper No. 6-864, November 1966.

8. Houston, B. J., Investigation of Nonmetallic Waterstops; Preliminary Laboratory and Field Exposure Tests, sponsored by Office, Chief of Engineers, U. S. Army; Technical Report No. 6-546, Report No. 1, May 1960.

9. _____, Investigation of Nonmetallic Waterstops; Progress Report of Laboratory and Field Exposure Tests, sponsored by Office, Chief of Engineers, U. S. Army; Technical Report No. 6-546, Report No. 3, June 1963.

10. _____, Investigation of Nonmetallic Waterstops Effect of Exposure, sponsored by Office, Chief of Engineers, U. S. Army; Technical Report No. 6-546, Report No. 6, January 1968.

11. Kennedy, T. B., Tensile Crack Exposure Tests, CWI Item No. 026, Tensile Crack Exposure Test for Reinforced Concrete Beams, Technical Memorandum No. 6-412, U. S. Army Engineer Waterways Experiment Station, CE, July 1955.

12. Roshore, E. C., Durability and Behavior of Prestressed Concrete Beams, Pretensioned Concrete Investigation; Progress to July 1960, Technical Report No. 6-570, Report 1, June 1961.

13. _____, Tensile Crack Exposure Tests; Results of Tests of Reinforced Concrete Beams, Technical Memorandum No. 6-412, Report 2, November 1964.

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14. Roshore, E. C. Durability and Behavior of Prestressed Concrete Beams; Posttensioned Concrete Investigation, Progress to July 1966, Technical Report No. 6-570, Report No. 6-570, Report 2, March 1967.

15. _____, Field Exposure Tests of Reinforced Concrete Beams, Miscellaneous Paper No. 6-868, January 1967.

16. _____, Durability and Behavior of Prestressed Concrete Beams; Laboratory Tests of Weathered Pretensioned Beams, Technical Report No. 6-570, Report 3, October 1971.

17. O'Neil, E. F., Durability and Behavior of Prestressed Concrete Beams; Posttensioned Concrete Beam Investigation with Laboratory Tests from June 1961 to September 1975, Technical Report No. 6-570, Report 4, February 1977.

18. _____, Durability and Behavior of Prestressed Concrete Beams; Laboratory Tests of Weathered Pretensioned Beams, Technical Report No. 6-570, Report 5, June 1976.

This report summarizes all investigations made to date, and is issued in loose-leaf form in order that it may be kept up to date by the addition of new material or revision of old material, as appropriate. The report is made up of two volumes: Volume 1 (this volume) summarizes the test results of investigations which are still active, and Volume 2 summarizes the findings of completed investigations.

The major part of the work reported herein and the preparation of this report constitute part of Civil Works Research Work Unit 31132, "Field Exposure Durability Studies of Concrete." The studies were made by the Concrete Technology Division, Structures Laboratory, Waterways Experiment Station. Personnel actively engaged in the direction and conduct of the work include Ms. K. Mather, Messrs. B. Mather, J. M. Scanlon, B. R. Sullivan, R. V. Tye, Jr., E. E. McCoy, E. C. Roshore, H. T. Thornton, R. E. Black, D. Glass, D. Wilson, and G. S. Harris. Mr. Thornton prepared this distribution.

During the preparation of this report COL Edmund H. Lang, CE, was Director of the Waterways Experiment Station, and Mr. J. B. Tiffany was Technical Director. During the preparation of this distribution of the Supplements, Corrections, and Revisions, COL John L. Cannon and

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COL Nelson P. Conover, CE, served as Commanders and Directors and Mr. F. R. Brown was Technical Director.

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CONVERSION FACTORS, INCH-POUND TO METRIC (SI) UNITS OF MEASUREMENT

1 inch = 25.4 millimetres

1 foot = 0.3048 metre

37°F = 2.8°C

-10°F = -23.4°C

28°F = -2.2°C

70°F = 21.1°C

1 lb = 0.453592 kilogram

1 bag of cement = 94 lb of cement = 42.637648 kilograms of cement

1 cu yd = 0.764555 cubic metre

1 gal (U. S.) = 3785.412 cubic centimetres

1 gal (U. S.) = 3.785412 cubic decimetres

1 cu ft = 0.028317 cubic metre

1 ton = 2000 lb = 907.184 kilograms

1 psi = 0.006894757 megapascals

1 fps = 0.3048 metre/second

1 lb/cu ft = 16.018477 kilograms/cubic metre

1 bag/cu yd = 55.767928 kilograms/cubic metre

1 gal/bag = 88.781398 cubic centimetres/kilogram

3-1/2 by 4-1/2 by 16 in. = approximately 90 by 115 by 410 millimetres

6 by 6 by 30 in. = approximately 150 by 150 by 760 millimetres

6 by 6 by 48 in. = approximately 150 by 150 by 1220 millimetres

18 by 18 by 36 in. = approximately 460 by 460 by 910 millimetres

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Table 1

Recapitulation of Specimens Exposed at Treat Island, Maine

Location			Specimens				Section
Section	Row	Program of Investigation	Size and Kind	No. Installed	No. Left	Date Installed	No. in This Vol
Beach	2	Tensile Crack Specimens, Series A	7-ft-9-in.-long beams	82	0	Nov 1951	1
Beach	1	Tensile Crack Specimens, Series B	7-ft-9-in.-long beams	76	75	Nov 1954	2
Rack	9	Stewart Field Spheres	1-ft spheres	24	12	May 1954	3
Beach	2	Cement-Replacement Materials Investigation, Phase B	18- by 18- by 36-in. prisms	21	6	Dec 1953	4
Beach	2	Prestressed Concrete Program	4-1/2- by 9- by 81-in. beams	16	0	Oct 1958	6
Rack	3	Prestressed Concrete Program	3-1/2- by 4-1/2- by 16-in. beams	72	57	Oct 1958	6
Beach	2	Prestressed Concrete Program	10- by 16- by 96-in. beams	20	12	June 1961	6
Rack	4	Cement-Replacement Materials Investigation, Phase D	10- by 20-in. cores	75	21	Oct 1958	8
Beach	1	Cement-Replacement Materials Investigation, Phase D	2-ft cubes	20	4	Oct 1958	8
Rack	8	Passamaquoddy Project	5- by 5- by 60-in. columns	43	1	June 1936	9
Rack	5	Missouri River Division Program	3-1/2- by 4-1/2- by 16-in. beams	12	5	Sept 1963	10
Rack	5	Missouri River Division Program	3- by 4-1/2- by 16-in. beams	3	2	Nov 1965	10
Rack	5	Portland Blast-Furnace Slag Cement Investigation	3-1/2- by 4-1/2- by 16-in. beams	108	66	May 1956	11
Rack	3	Specimen Size-Frost Effects Investigation	3-1/2- by 4-1/2- by 16-in. beams	9	9	Dec 1968	12
Rack	2	↓	6- by 6- by 30-in. beams	3	3	Dec 1968	12
Rack	3	↓	2-ft cubes	3	3	Dec 1968	12
Rack	2	↓	18- by 18- by 36-in. prisms	3	3	Dec 1968	12
Rack	3	Trumbull Pond Dam Prisms	18- by 18- by 36-in. prisms	6	6	June 1972	13
Rack	2	Investigation of 4-1/2-in. Aggregate Concrete	18- by 18- by 36-in. prisms	12	5	Dec 1968	14
Rack	3	Longtime Study, Waterways Experiment Station	3-1/2- by 4-1/2- by 16-in. beams	198	196	May 1955	17
Rack	4	Mt. Morris Dam Cores	10-in.-diam by 18-in. cores	11	3	Oct 1949	22
Rack	2	Air-Entraining Admixture Study	6- by 6- by 30-in. prisms	90	13	Nov 1944	25
Rack	2	Omaha District Aggregate Program	6- by 6- by 30-in. beams	6	3	Dec 1956	26
Rack	2	Omaha District Aggregate Program	↓	3	0	Nov 1964	26
Rack	2	Kansas City District Aggregate Program	↓	18	6	Jan 1958	27
Rack	2	↓	↓	18	1	May 1959	27
Rack	2	↓	↓	9	5	Nov 1962	27
Rack	2	↓	↓	9	5	Dec 1963	27
Rack	2	↓	↓	3	3	May 1969	27
Rack	2	↓	↓	3	3	July 1974	27
Rack	2	↓	↓	3	3	July 1974	27
Beach	1	Bufaula Dam Aggregates Study	2-ft cubes	3	3	Oct 1958	28
Rack	N wall	Nonmetallic Waterstop Investigation	Waterstop pieces	54	16	May 1957	30
—	—	↓	Embedded waterstop pieces	27	0	May 1957	30
Rack	N wall	↓	Waterstop pieces	30	0	Nov 1957	30
—	—	↓	Embedded waterstop pieces	15	0	Nov 1957	30
Rack	N wall	↓	Waterstop pieces	2	0	Aug 1958	30
—	—	↓	Embedded waterstop pieces	1	0	Aug 1958	30
Rack	5	Woven Plastic Test Program	13-in. squares	160	0	Nov 1963	31
—	—	Woven Plastic Test Program	13-in. squares	80	0	Apr 1967	31
Rack	5	Woven Plastic Test Program	13-in. squares	22	0	Mar 1970	31
Top of wharf		Membrane Curing Program	Box specimens	14	14	June 1946	34
Beach	2	Quality Aggregate Investigation	2-ft cubes	10	0	Nov 1962	35
Beach	A-1	Quality Aggregate Investigation	2-ft cubes	6	2	Dec 1963	35
Beach	2	Cement-Replacement Materials Investigation, Phase G	18- by 18- by 36-in. prisms	2	0	Nov 1962	36
Beach	2	Maximum Size of Coarse Aggregate Program	↓	18	9	Dec 1963	37
Beach	A-1	Maximum Allowable Water-Cement Ratio Investigation	↓	24	12	Dec 1964	38
Rack	1	Curing Investigation	↓	56	56	June 1968	39
Rack	5	Investigation of Plastic Based Mortar Coatings	10- by 10- by 3-in. mortar-coated panels	8	8	July 1969	40
Rack	5	Investigation of Plastic Based Mortar Coatings	10- by 10- by 3-in. mortar-coated panels	8	8	Nov 1969	40
Rack	5	Investigation of Plastic Based Mortar Coatings	10- by 10- by 3-in. mortar-coated panels	16	16	Dec 1970	40
Rack	3	CERL Fibrous Concrete	3-1/2- by 4-1/2- by 16-in. beams	30	10	Jan 1975	5
Rack	4 & 6	WES Fibrous Concrete	9- by 9- by 45-in. beams	17	17	June 1975	7
Rack	5	WES Fibrous Concrete	6- by 6- by 30-in. beams	12	12	June 1975	7
Rack	5	WES Fibrous Concrete	6- by 6- by 36-in. beams	21	21	June 1975	7
Rack	9	Sulfur-Infiltrated Concrete	4- by 8-in. cylinders	18	18	Aug 1976	15
Rack	9	Sulfur-Infiltrated Concrete	3- by 6-in. cylinders	36	36	Aug 1976	15
Rack	6	Roller-Compacted Concrete	12- by 12- by 36-in. beams	6	6	July 1977	16
Rack	6	Charles River - Smelt Brook	6- by 6- by 24-in. beams	18	18	Aug 1976	18
Rack	7	Concrete-Polymer Materials	6- by 6- by 30-in. beams	12	12	Jul 1978	19
Rack	8	Cement Replacement-High Range Water-Reducing Admixtures	1- by 1- by 3-ft prisms	36	36	Oct 1978	20
Rack	9	Cement Replacement-High Range Water-Reducing Admixtures	6- by 12-in. cylinders	102	100	Oct 1978	20

— Dashed lines in "Section" and "Row" columns indicate that these specimens are no longer on the exposure rack.

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Table 2

Recapitulation of Specimens Exposed at St. Augustine, Fla.

Program of Investigation	Specimens: Size and Kind	Specimens: No. Installed	Specimens: No. Left	Specimens: Date Installed	Sec. No. in This Vol
Prestressed Concrete Program	4-1/2- by 9- by 81-in. beams	3	1	Oct 1959	6
Portland Blast-Furnace Slag Cement Investigation	3-1/2- by 4-1/2- by 16-in. beams	108	93	Aug 1956	11
	8-1/2- by 8-1/2- by 12-in. prisms	45	0	Aug 1956	11
Longtime Study Waterways Experiment Station	3-1/2- by 4-1/2- by 16-in. beams	198	195	Aug 1955	17
Alkali-Aggregate Reactivity Investigation	6- by 6- 30-in. beams	72	45	Aug 1955	29
	6- by 6- by 30-in. beams	36	30	Aug 1956	29
National Bureau of Standards Supersulfate Cement Program	3- by 4- by 16-in. beams	27	19	Nov 1957	32

Note: Installation and testing of specimens at St. Augustine, Fla., was discontinued in November 1971.

Table 1-TC-B (Continued)

Beach Row 1

Beam No.	Nominal Stress psi	Steel Position	Type Steel Deformation	1977- Readings: 3095 Cycles, 1977 Condition	3095 Cycles, 1977 SV^2	3095 Cycles, 1977 Max Crack Width 1/1000 in.	3242 Cycles, 1978 Condition	3242 Cycles, 1978 SV^2	3242 Cycles, 1978 Max Crack Width 1/1000 in.	3335 Cycles, 1979 Condition	3335 Cycles, 1979 SV^2	3335 Cycles, 1979 Max Crack Width 1/1000 in.
83	20,000	B	A-305	22	80	15	47	78	15	34	85	15
84	20,000	B	A-305	60	74	25	64	47	30	64	72	30
85	20,000	B	OS	68	88	25	66	40	20	59	68	-
86	20,000	B	OS	65	69	25	67	58	25	63	70	25
87	20,000	B	A-305	46	66	20	46	32	20	44	71	20
88	20,000	B	A-305	51	53	20	53	52	20	46	97	20
89	20,000	B	OS	63	46	25	64	56	25	61	95	25
90	20,000	B	OS	58	59	25	56	49	20	58	56	20
91	30,000	B	A-305	68	60	25	69	38	30	66	98	30
92	30,000	B	A-305	65	84	25	66	39	25	64	62	25
93	30,000	B	OS	63	51	55	65	44	60	64	72	60
94	30,000	B	OS	63	68	70	65	60	75	60	55	75
95	30,000	B	A-305	60	76	25	46	63	20	42	63	20
96	30,000	B	A-305	64	86	25	65	60	96	63	99	30
97	30,000	B	OS	62	76	50	63	66	40	62	75	40
98	30,000	B	OS	59	63	50	61	54	50	55	70	100
99	40,000	B	A-305	56	92	60	59	54	75	59	56	75
100	40,000	B	A-305	56	72	55	56	41	50	43	81	100
101	40,000	B	OS	56	54	80	57	43	80	56	63	80
102	40,000	B	OS	58	53	100	56	58	125	54	65	125
103	40,000	B	A-305	47	86	60	47	57	60	46	139	60
104	40,000	B	A-305	64	62	60	58	73	75	56	124	75
105	40,000	B	OS	65	82	75	65	58	80	88	117	80
106	40,000	B	OS	66	69	70	90	76	(1/4-in. spall)	91	97	(1/4-in. spall)
107	50,000	B	A-305	50	46	(1-in. spall)	51	55	(1-in. spall)	49	83	(1-in. spall)
108	50,000	B	A-305	53	44	(5/8-in. spall)	54	33	(5/8-in. spall)	49	53	(3/8-in. spall)
109	50,000	B	OS	65	115	(1-1/2 in. spall)	64	54	(2-in. spall)	56	97	(2-in. spall)
110	50,000	B	OS	53	94	75	55	62	100	53	109	100
111	50,000	B	A-305	50	68	75	55	43	100	49	83	100
112	50,000	B	A-305	59	67	75	61	50	(1-in. spall)	62	90	(1-in. spall)
113	50,000	B	OS	47	79	(1/4-in. spall)	48	48	(1/4-in. spall)	46	106	(1/4-in. spall)
114	50,000	B	OS	51	101	100	51	56	(1/2-in. spall)	51	151	(1/2-in. spall)
115	None	B	A-305	51	78		49	43		46	58	—
116	None	B	A-305	57	76		57	25		62	61	—
117	None	B	A-305	59	44		53	45	30	52	61	30
118	None	B	OS	44	64		42	22		39	20	—
119	None	B	OS	55	43		52	70		45	63	—
120	None	B	OS	54	79		55	50		53	49	—
121	20,000	T	A-305	70	92	35	73	52	30	71	146	30
122	20,000	T	A-305	67	97	35	69	60	30	67	140	30
123	20,000	T	OS	59	65	60	59	51	100	52	71	100
124	20,000	T	OS	63	71	60	63	47	60	63	98	60
125	20,000	T	A-305	57	54	30	59	30	25	57	86	25
126	20,000	T	A-305	75	54	30	76	37	25	74	541	25
127	20,000	T	OS	66	68	20	68	61	20	55	57	20
128	20,000	T	OS	67	65	20	68	35	15	57	53	50
129	30,000	T	A-305	52	93	50	54	96	60	53	92	60
130	30,000	T	A-305	60	83	60	61	69	75	56	78	75
131	30,000	T	OS	70	49	75	72	60	75	72	76	75
132	30,000	T	OS	54	53	75	56	60	(1/4-in. spall)	47	64	(1/4-in. spall)
133	30,000	T	A-305	58	91	50	58	47	50	58	57	50
134	30,000	T	A-305	62	72	75	64	54	50	63	45	50
135	30,000	T	OS	61	43	40	61	29	40	60	60	40
136	30,000	T	OS	62	59	40	63	38	50	58	83	50
137	40,000	T	A-305	49	79	100	50	37	110	49	70	110
138	40,000	T	A-305	55	77	75	56	34	90	54	83	90
139	40,000	T	OS	65	69	55	66	39	65	64	57	65
140	40,000	T	OS	65	81	60	67	29	70	67	54	70
141	40,000	T	A-305	59	94	60	53	73	75	52	92	75
142	40,000	T	A-305	57	86	60	62	75	50	59	106	50
143	40,000	T	OS	62	81	75	63	71	75	62	98	75
144	40,000	T	OS	57	93	(3/8-in. spall)	52	88	(1-in. spall)	51	117	(1-in. spall)
145	50,000	T	A-305	52	89	125	52	73	150	50	89	150
146	50,000	T	A-305	47	73	80	47	54	75	43	113	75

(Continued

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Table 1-TC-B (Continued)

Section 2

Beach Row 1

Beam No.	Nominal Stress psi	Steel Position	Type Steel Deformation	1973-1976 Readings: 2624 Cycles, 1973 Condition	2624 Cycles, 1973 $\frac{1}{V^2}$	2624 Cycles, 1973 Max Crack Width 1/1000 in.	2760 Cycles, 1974 Condition	2760 Cycles, 1974 $\frac{1}{V^2}$	2760 Cycles, 1974 Max Crack Width 1/1000 in.	2872 Cycles, 1975 Condition	2872 Cycles, 1975 $\frac{1}{V^2}$	2872 Cycles, 1975 Max Crack Width 1/1000 in.	3028 Cycles, 1976 Condition	3028 Cycles, 1976 $\frac{1}{V^2}$	3028 Cycles, 1976 Max Crack Width 1/1000 in.
148	50,000	T	OS		##		Unloaded	##	--	--	--	--	--	--	--
149	50,000	T	A-305	68		75	66		500¶	61	73	500	61	100	(4-in. spall)
150	50,000	T	A-305	65		60	65		70	62	61	70	64	104	75
151	50,000	T	OS	57		70	58		70	57	62	60	56	63	(1/2-in. spall)
152	50,000	T	OS	54		60	54		55	51	52	50	53	52	50
153	None	T	A-305	44		0	36		0	16	50		26	52	
154	None	T	A-305	55		0	54		0	54	84		55	81	
155	None	T	A-305	76		0	65		0	61	82		65	81	
156	None	T	OS	52		0	27		0	25	83		22	81	
157	None	T	OS	52		0	51		0	49	83		50	90	
158	None	T	OS	51		0	50		0	50	74		51	79	(2-in. spall)

Beam No.	Nominal Stress psi	Steel Position	Type Steel Deformation	1977- Readings: 3095 Cycles, 1977 Condition	3095 Cycles, 1977 $\frac{1}{V^2}$	3095 Cycles, 1977 Max Crack Width 1/1000 in.	3242 Cycles, 1978 Condition	3242 Cycles, 1978 $\frac{1}{V^2}$	3242 Cycles, 1978 Max Crack Width 1/1000 in.	3341 Cycles, 1979 Condition	3341 Cycles, 1979 $\frac{1}{V^2}$	3341 Cycles, 1979 Max Crack Width 1/1000 in.
148	50,000	T	OS	--	--	--	--	--	--	--	--	--
149	50,000	T	A-305	64	67	(4-in. spall)	62	50	(6-in. spall)	61	93	(6-in. spall)
150	50,000	T	A-305	63	65	75	63	60	75	62	90	75
151	50,000	T	OS	53	63	(5/8-in. spall)	45	32	(1-in. spall)	45	54	(1-in. spall)
152	50,000	T	OS	53	67	50	54	33	50	52	96	50
153	None	T	A-305	29	53		26	35		19	55	--
154	None	T	A-305	55	74		61	24		59	--	--
155	None	T	A-305	,	82		66	53		65	52	--
156	None	T	OS	23	82		23	52		21	56	--
157	None	T	OS	54	80		57	28		49	82	--
158	None	T	OS	50	68		52	36	(2-in. spall)	50	74	(2-in. spall)

Satisfactory pulse velocity readings were not obtained in 1973 and 1974.
¶ One rebar failed during winter of 1973-1974.

(Revised August 1980)

Table 1-SF (Continued)

Exposure Rack, Row 9 (W to E)

Sphere No.	Aggregate Combination Fine	Coarse	Water-Cement Ratio gal/bag	Cement Factor bags/cu yd	Air %	1973-Readings 1973 %v²	1974 %v²	1975 %v²	1976 %v²	1977 %v²	1978 %v²	1979 %v²
11B	Nat. sand A	Nat. gravel A	4.5	7.1	4.0	52	49	33	NR	Failed		
12D	Nat. sand A	Nat. gravel A	5.0	6.2	2.3	NR	NR	NR	NR	NR	Failed	
13D	Nat. sand A	Nat. gravel A	5.5	5.3	4.7	NR	NR	NR	NR	NR	Failed	
21A	Crushed	Nat. gravel A	4.5	7.3	4.5	66	60	80	73	73	73	66
21B	Crushed	Nat. gravel A	4.5	7.3	4.3	78	76	72	62	65	65	62
22A	Crushed	Nat. gravel A	5.0	6.4	4.8	95	93	88	81	83	83	79
23A	Crushed	Nat. gravel A	5.5	5.6	4.5	62	62	70	65	62	59	52
23B	Crushed	Nat. gravel A	5.5	5.6	4.6	43	40	67	61	63	61	57
53A	Blend B	Nat. gravel A	5.5	5.2	5.1	NR	NR	NR	Failed			
53E	Blend A	Nat. gravel A	5.5	5.1	4.3	NR	NR	NR	Failed			
71A	Crushed	Rock C	4.5	7.4	6.8	Failed						
92E	Blend C	Rock C	5.0	6.3	3.9	NR	NR	NR	Failed			
13G	Nat. sand A	Nat. gravel A	5.5	5.2	3.8	NR	NR	NR	Failed			

NR A satisfactory reading was not obtained although an attempt was made to obtain one.

(Revised August 1980)

Table 1-CRMI-PB (Continued) Section 4

Record of Testing of Prisms Made for Cement-Replacement Materials Investigation,

Phase B, 1953- (Installed December 1953)

Beach Row 2

Mix No.	Specimen No.	Portland Cement %	Max Aggr Size in.	1976- Readings: 3040 Cycles 1976 $\%v^2$	3117 Cycles 1977 $\%v^2$	3264 Cycles 1978 $\%v^2$	3357 Cycles 1979 $\%v^2$
a	B-11	100	6				
b	B-30	100	3	75	70	65	42
	B-31			89	71	54	50
	B-32			91	101	70	39
c	B-61	100	3*	96	108	107	81
	B-62			96	97	106	81
	B-63						
d	B-48	55†	6				
e	B-110	65‡	6				
	B-111						
f	B-77	55†	3				
	B-78						
	B-79						
g	B-93	65‡	3	88	90	91	65
	B-94						
	B-95						

(Sheet 2)

* Water-cement ratio (by wt), 0.5; that of all other specimens, 0.8.
† 45% fly ash used as replacement material.
‡ 35% natural cement used as replacement material.

Table 1-CERL-FC

Record of Testing of Concrete Beams for CERL Fibrous Concrete Program

Installed January 1975

Rack Row 3

Mix No.	Beam No.	Flaw in.	1975-1977 Readings: Jan 1975 0 cycles %E	fps	%V²	Jun 1975 66 cycles %E	%V²	1976 212 cycles %E	%V²	1977 289 cycles %E	%V²
0-1	0	0	100	14,150	100	110	161	110	102	110	94
	1	0	100	14,000	100	104	145	109	104	109	87
	2	0	100	13,855	100	105	148	††			
	3	H.L.*	100	13,040	100	**	**	††			
	4	1/16†	100	13,435	100	**	**	††			
	5	1/8	100	13,300	100	**	**	††			
0-2	10	0	100	13,435	100	102	157	103	94	105	94
	11	0	100	13,570	100	100	158	99	100	101	94
	12	0	100	13,435	100	101	165	††			
	13	H.L.	100	13,300	100	101	160	††			
	14	1/16	100	12,545	100	85	176	††			
	15	1/8	100	12,545	100	90	156	††			
0-3	20	0	100	14,150	100	104	153	104	104	108	94
	21	0	100	14,300	100	104	154	105	96	109	94
	22	0	100	14,150	100	101	157	††			
	23	H.L.	100	13,855	100	100	168	††			
	24	1/16	100	13,435	100	79	161	††			
	25	1/8	100	13,570	100	93	150	††			
0-4	30	0	100	13,855	100	101	155	111	96	111	102
	31	0	100	13,570	100	108	154	113	106	115	89
	32	0	100	13,855	100	102	160	††			
	33	H.L.	100	13,435	100	102	153	††			
	34	1/16	100	13,040	100	100	159	††			
	35	1/8	100	12,915	100	78	170	††			
0-5	40	0	100	14,150	100	100	161	114	112	113	98
	41	0	100	14,150	100	103	157	104	107	109	98
	42	0	100	14,000	100	101	174	††			
	43	H.L.	100	13,855	100	97	164	††			
	44	1/16	100	13,170	100	77	172	††			
	45	1/8	100	12,915	100	72	158	††			

(Continued)

* Hairline crack.
** Unable to obtain reading.
† In two pieces.
†† Shipped to CERL in July 1976 for laboratory tests.

Table 1-CERL-FC (Continued)

Rack Row 3

Mix No.	Beam No.	Flaw in.	1978- Readings 1978 436 cycles %E	1978 436 cycles $\%V^2$	1979 529 cycles %E	1979 529 cycles $\%V^2$
0-1	0	0	111	88	**	**
	1	0	109	87	116	92
	2	0				
	3	H.L.*				
	4	1/16†				
	5	1/8				
0-2	10	0	106	92	109	92
	11	0	104	98	104	100
	12	0				
	13	H.L.				
	14	1/16				
	15	1/8				
0-3	20	0	109	94	111	96
	21	0	109	86	110	96
	22	0				
	23	H.L.				
	24	1/16				
	25	1/8				
0-4	30	0	114	102	110	98
	31	0	116	92	114	95
	32	0				
	33	H.L.				
	34	1/16				
	35	1/8				
0-5	40	0	114	92	113	85
	41	0	109	**	109	98
	42	0				
	43	H.L.				
	44	1/16				
	45	1/8				

* Hairline crack.
** Unable to obtain reading.
† In two pieces.

(Revised August 1980)

Table 2-PR (Continued)

Exposure Rack, Row 3 (W to E)

Beam No.	Batch No.	Type Concrete	1958-1967 Readings: 0 Cycles 1958 %E	150 Cycles 1959 %E	221 Cycles 1960 %E	362 Cycles 1961 %E	451 Cycles 1962 %E	557 Cycles 1963 %E	692 Cycles 1964 %E	855 Cycles 1965 %E	985 Cycles 1966 %E	1141 Cycles 1967 %E
6894	19	Air	100	104	103	97	99	101	97	97	97	93
6896			100	103	101	95	98	92	97	95	96	95
6898			100	107	105	99	103	105	103	101	102	102
6900	20	Air	100	107	105	99	104	105	104	103	108	108
6902			100	108	105	99	104	105	104	103	104	103
6904			100	107	105	99	102	102	102	101	103	103
6906	21	Air	100	105	103	98	101	102	96	98	100	100
6908			100	105	104	98	101	102	99	100	101	101
6910			100	105	103	98	101	104	101	101	97	99
6912	22	Air	100	105	103	98	102	104	103	102	102	103
6914			100	102	101	96	99	100	100	100	100	102
6916			100	105	103	98	101	102	100	100	100	101
6918	23	Plain	100	108	107	99	97	91	86	87	84	87
6920			100	109	107	95	88	80	70	65	43 Failed	
6922			100	105	104	99	100	101	104	106	106	108
6924	24	Plain	100	108	106	101	103	106	106	106	106	107
6926			100	103	100	95	95	93	95	92	90	94
6928			100	106	103	95	92	93	86	82	48 Failed	

Beam No.	Batch No.	Type Concrete	1968-1978 Readings: 1326 Cycles 1968 %E	1480 Cycles 1969 %E	1633 Cycles 1970 %E	1802 Cycles 1971 %E	1959 Cycles 1972 %E	2099 Cycles 1973 %E	2235 Cycles 1974 %E	2347 Cycles 1975 %E	2493 Cycles 1976 %E	2570 Cycles 1977 %E	2717 Cycles 1978 %E
6770	1	Air	104	102	99	95	95	104	106	108	119	130	99
6772			99	100	98	95	95	141	147	147	158	108	119
6774			99	101	101	99	98	145	145	146	144	144	109
6776	2	Air	92	94	90	88	88	93	101	103	99	103	101
6778			99	98	94	92	90	94	99	102	98	104	113
6780			102	98	96	91	90	101	100	101	99	110	114
6782	3	Air	98	98	96	91	91	91	93	9[illegible]	95	95	113
6784			98	96	96	91	89	91	92	[illegible]4	94	110	109
6786			98	98	97	95	94	90	92	96	93	92	107
6788	4	Air	95	95	93	95	94	89	89	92	89	92	94
6790			101	101	99	101	99	95	103	103	107	109	105
6792			101	105	103	98	100	100	102	106	108	100	102
6806	5	Air	99	99	97	90	91	89	91	91	96	98	96
6808			93	96	96	90	94	89	94	95	97	84	91
6812	6	Air	88	93	91	91	82	82	85	86	84	80	89
6814			94	98	98	88	90	92	92	93	90	74	100
6816	7	Air	90	87	89	83	87	78	80	80	75	70	78
6818			86	84	86	84	84	79	79	79	74	59	58
6820			84	82	84	82	83	75	72	74	62	87	Failed
6822	8	Air	91	86	88	88	87	87	89	89	82	64	101
6824			87	83	87	74	74	83	84	86	80	79	93
6826			83	83	82	88	89	76	76	79	80	80	93
6828	9	Air	91	89	89	79	81	83	80	82	75	60	86
6830			88	84	86	74	73	71	71	73	53	136	99
6832			88	84	86	85	86	86	79	81	77	117	91
6834	10	Air	92	88	90	92	90	84	85	85	78	88	98
6836			94	91	93	87	90	85	85	89	81	90	103
6838			100	97	98	95	94	90	90	92	90	86	121
6846	11	Air	100	95	97	88	87	85	87	8[illegible]	87	82	136
6848			90	88	90	84	83	76	78	78	78	90	111
6850			92	88	90	90	89	87	89	90			105
6852	12	Air	96	93	96	89	89	92	92	92	88	97	105
6854			94	94	93	90	89	86	87	89	92	89	98
6856			90	92	91	82	83	84	82	83	89	105	86

(Continued)

(Revised August 1980)

Table 2-PR (Continued)

Section 6

Exposure Rack, Row 3 (W to E)

Beam No.	Batch No.	Type Concrete	1968-1978 Readings: 1326 Cycles 1968 %E	1480 Cycles 1969 %E	1633 Cycles 1970 %E	1802 Cycles 1971 %E	1959 Cycles 1972 %E	2099 Cycles 1973 %E	2235 Cycles 1974 %E	2347 Cycles 1975 %E	2493 Cycles 1976 %E	2570 Cycles 1977 %E	2717 Cycles 1978 %E
6858	13	Air	90	90	90	87	87	85	86	88	88	89	101
6860			91	90	92	99	99	88	87	88	88	90	110
6862			102	101	99	96	96	102	104	104	107	109	128
6864	14	Air	99	96	97	90	91	95	94	96	93	93	108
6866			98	98	96	90	91	90	90	91	90	85	104
6868			97	96	95	97	92	90	91	93	89	90	99
6870	15	Plain	87	85	84	Failed							
6872			97	95	93	Failed							
6874			92	90	91	Failed							
6876	16	Plain	79	77	Failed								
6878			79	76	Failed								
6880			82	79	Failed								
6882	17	Air	99	97	Disappeared from exposure rack								
6884			102	100	Disappeared from exposure rack								
6886			100	96	98	97	96	99	99	100	92	99	138
6888	18	Air	102	100	97	95	93	96	96	97	97	98	133
6890			100	101	99	94	93	94	95	95	95	82	110
6892			102	101	104	103	102	106	107	107	103	109	137
6894	19	Air	95	92	90	88	87	89	91	92	73	80	128
6896			96	96	88	87	85	85	86	87	53	111	119
6898			103	101	103	100	98	109	109	108	119	84	121
6900	20	Air	108	107	105	101	98	110	110	111	120	109	125
6902			105	103	102	100	99	109	104	107	107	108	131
6904			101	98	101	110	111	117	116	117	121	115	125
6906	21	Air	96	92	96	107	109	114	114	114	124	103	135
6908			100	102	99	105	106	113	113	114	118	118	124
6910			101	100	95	107	111	109	117	116	119	113	121
6912	22	Air	103	103	101	109	108	110	111	111	113	103	118
6914			102	100	98	108	106	113	112	112	114	128	145
6916			101	102	100	114	113	114	115	115	117	117	131
6918	23	Plain	76	74	74	94	95	115	113	114	111	112	138
6922			107	Failed									
6924	24	Plain	106	Failed									
6926			92	Failed									

Beam No.	Batch No.	Type Concrete	2810 Cycles 1979 %E
6770	1	Air	101
6772			119
6774			109
6776	2	Air	107
6778			114
6780			122
6782	3	Air	115
6784			114
6786			107
6788	4	Air	99
6790			105
6792			108
6806	5	Air	99
6808			92
6812	6	Air	103
6814			92
6816	7	Air	78
6818			62

(Continued)

Table 2-PR (Concluded)

Exposure Rack, Row 3 (W to F)

1979- Readings

Beam No.	Batch No.	Type Concrete	2810 Cycles 1979 %E
6822	8	Air	106
6824			102
6826			98
6828	9	Air	97
6830			103
6832			93
6834	10	Air	105
6836			104
6838			122
6846	11	Air	130
6848			112
6850			110
6852	12	Air	109
6854			99
6856			86
6858	13	Air	104
6860			121
6862			136
6864	14	Air	113
6866			105
6868			102
6882	17	Air	
6884			
6886			144
6888	18	Air	144
6890			111
6892			138
6894	19	Air	129
6896			120
6898			125
6900	20	Air	130
6902			130
6904			126
6906	21	Air	135
6908			127
6910			122
6912	22	Air	122
6914			139
6916			133
6918	23	Plain	142

Table 5-PR (Continued)

Beach Row 2 (W to E)

Beam No.	1118 Cycles, 1969			1271 Cycles, 1970			1440 Cycles, 1971			1597 Cycles, 1972			1737 Cycles, 1973		
	fV^2		Condition	fV^2		Condition	fV^2		Condition	fV^2		Condition	fV^2		Condition
	Trans	Long.		Trans	Long.		Trans	Long.		Trans	Long.		Trans	Long.	
1	128	96	26	130	94	31	93	88	26	85	84	28	$	$	29
2	98	84	31	89	87	30	60	73	33	62	75	34			37
3	105	87	33	105	90	28	79	73	26	40	66	32			22
4	100	110	26	82	111	39	57	85	36	60	88	30			31
5	112	92	23	103	94	30	73	78	33	41	65	26			21
6	92	100	23	85	101	27	62	75	28	58	70	22			31
7	87	95	31	81	96	49	60	83	48	56	80	54			45
8	108	89	67	95	90	52	71	**	49	63	**	52			47
9	89	60	36	79	62	53	56	**	48	34	**	39			54
10	92	80	29	82	85	29	58	**	31	33	**	34			32
11	87	79	20	76	81	26	61	62	27	43	50	18			12
12	88	64	24	81	64	30	70	77	40	22	65	26			41
13	74	73	30	76	74	27	75	**	30	37	**	21			23
14	85	97	37	82	97	35	63	64	45	48	63	36			46
15	74	98	23	69	100	26	62	69	26	26	69	24			43
16	81	96	21	78	98	22	70	74	20	26	95	26			19
17	72	85	69	76	99	75	64	**	70	45	**	70			70
18	76	75	50	74	88	46	66	63	42	30	76	34			41
19	76	**	68	74	**	72	62	**	65	37	**	69			67
20	78	97	37	83	98	34	54	77	32	56	92	30			41

	1873 Cycles, 1974			1985 Cycles, 1975			2131 Cycles, 1976			2208 Cycles, 1977			2355 Cycles, 1978		
	fV^2		Condition	fV^2		Condition	fV^2		Condition	fV^2		Condition	fV^2		Condition
	Trans	Long.		Trans	Long.		Trans	Long.		Trans	Long.		Trans	Long.	
1	$	$	32	§§											
2			40	60	60	46	53	58	47	52	54	52	51	52	40
3			§§												
4			35	*	114	16	**	93	35	**	83	39	**	76	34
5			30	††	113	24	**	104	29	**	101	41	**	43	44
6			40	§§											
7			53	*	85	46	**	84	56	**	74	68	**		78
8			54	70	57	44	54	57	59	55	55	75	54	47	75
9			§§												
10			50	62	94	38	32	95	56	29	84	64	49	84	50
11			22	§§											
12			65	65	103	29	57	93	44	57	87	41	39	59	46
13			§§												
14			51	60	67	36	53	68	55	53	64	59	52	60	50
15			§§												
16			41	52	111	18	46	106	40	45	90	44	45	94	58
17			77	§	§	72	**	**	82	**	**	93	**	**	94
18			47	61	86	33	47	87	60	48	80	55	48	37	67
19			§§												
20			42	51	90	32	41	91	50	41	88	55	44	85	55

	2448 Cycles, 1979		
	fV^2		Condition
	Trans	Long.	
1	§§	§§	§§
2	**	48	61
3			
4		65	57
5		77	48
6	§§		
7	**		141
8			136
9			
10		61	100
11	§§		
12	**	51	51
13			
14		45	74
15			
16	**	61	57
17		70	148
18		37	98
19			
20		53	63

** A satisfactory reading was not obtained.

(Sheet 2)

§ Satisfactory pulse velocity readings were not obtained in 1973 and 1974.

§§ Shipped back to Concrete Laboratory.

Table 6-PR (Continued) Section 6

Beach Row 2

Type of End Protection	No. of Beam Ends Used	Average Condition 2355 Cycles 1978	Average Condition 2448 Cycles 1979
Flush (1)	2	12§	Failed
Flush (6)	2	4	4
Flush (7)	2	5§	2§
Flush (9)	2	2§	1§
Ext (1)	4		
Ext (2)	4	14	18
Ext (3)	4		
Ext (4)	4	16	21
Ext (5)	4		
Ext (6)	4		
Ext (7)	4	2§§	2§§
Ext (8)	4	4§§	7§§
Total	40		

§ Based on 1 beam end.
§§ Based on 3 beams ends.

(Revised August 1980)

Table 1-WES-FC

Section 7

Record of Testing of Concrete Beams for WES Fibrous Concrete Program

Installed July 1975

Rack Rows 4 and 6

		1975- Readings									
		Jul 1975 0 Cycles		1976 146 Cycles		1977 223 Cycles		1978 370 Cycles		1979 463 Cycles	
Beam No.	Load, lb	%E	fps	%V²	%E	%V²	%E	%V²	%E	%V²	%E	%V²
					9- by 9- by 45-in. Beams							
H-3	2720	*	16,095	100	*	103	*	102	*	101	*	106
I-1	4340		15,560			97		97		9[illegible]		94
I-3			16,375			101		98		97		101
J-1			14,315			103		102		100		97
J-3			14,590			106		105		101		102
K-1			14,590			104		102		100		101
K-3			14,260			103		100		100		99
L-1			16,520			94		93		94		82
L-3			16,305			99		101		98		95
M-1			14,590			98		99		98		100
M-3			15,060			101		100		99		103
N-1			14,765			108		103		104		106
N-3			14,705			103		103		102		109
O-1			14,150			108		107		105		110
O-3			14,370			107		105		102		105
P-1			14,940			106		103		102		107
P-2			15,245			109		105		105		111
					6- by 6- by 30-in. Beams							
H-7	None	100	16,235	100	98	105	106	103	102	103	101	103
H-8			15,725		102	105	109	100	100	101	98	100
H-15			15,825		106	107	110	101	102	103	102	105
H-16			15,825		102	108	108	99	102	101	103	104
I-8			15,925		120	105	116	97	102	103	102	101
K-8			14,970		109	109	125	99	116	101	107	104
L-7			16,130		94	108	109	100	105	101	103	99
L-8			16,130		103	108	103	101	101	101	102	97
M-7			14,125		100	102	103	94	103	97	101	93
O-8			13,890		100	103	103	101	105	97	100	99
O-16			15,245		88	110	97	100	95	101	97	102
P-8			14,705		106	105	106	100	104	100	109	100
					6- by 6- by 36-in. Beams							
I-7	None	100	15,875	100	119	103	96	98	94	99	94	86
I-15			16,130		105	109	114	102	111	103	111	103
J-7			14,495		103	106	112	99	100	101	97	103
J-8			14,495		109	104	118	96	97	98	190	98
J-15			14,495		100	104	100	97	100	99	97	99
J-16			14,565		115	109	106	103	112	101	100	102
K-7			14,780		103	106	109	98	115	100	95	100
K-15			14,565		106	106	103	101	97	103	154	105
K-16			14,285		102	109	100	102	100	104	101	102
L-15			14,635		104	104	108	101	102	101	107	98
L-16			14,635		103	103	106	100	106	100	97	99
M-8			14,085		205	109	210	99	210	101	201	100
M-15			15,075		100	104	109	99	103	97	190	97
M-16			14,850		112	109	109	102	112	91	109	99
N-7			14,150		118	105	106	109	112	105	105	102
N-8			14,085		112	102	124	99	131	95	104	97
N-15			14,020		109	106	112	101	106	102	102	100
N-16			14,020		100	110	112	102	102	103	102	103
O-7			13,825		106	110	109	103	103	105	100	103
O-15			12,710		97	108	103	102	100	101	97	101
P-7			14,635		109	107	109	98	105	101	106	105

* Loaded beams not tested for %E.

(Revised August 1980)

Table 1-CRMI-PD (Continued)

Exposure Rack, Row 4 (W to E)

Core No.	Cementitious Mat'l: Type II Portland Cement %	Cementitious Mat'l: Replacement Material %	Nominal Cement Factor bags/cu yd	Water-Cement Ratio by wt	Air Content %	1974-1977 Readings: 2235 Cycles 1974 %E	2235 Cycles 1974 $\%V^2$	2347 Cycles 1975 %E	2347 Cycles 1975 $\%V^2$	2493 Cycles 1976 %E	2493 Cycles 1976 $\%V^2$	2570 Cycles 1977 %E	2570 Cycles 1977 $\%V^2$
5M	100	0	2-1/4	0.73	3.9-6.1	70	53	70	94	60	75	64	Broken
5B						NR	69	NR	NR	Failed			
12T	100	0	3	0.55	6.3-7.4	62	92	62	93	60	73	46	65
12M						48	68	NR	96	Failed			
13T	75	Pumicite 25	3	0.58	6.2-7.6	73	†	—	—	Failed			
13M						NR	66	Failed	Failed				
13B						96	89	96	113	NR	88	75	79
15T	65	Nat cem 35	3	0.56	6.5-8.7	70	91	70	94	68	94	60	88
15M						63	94	62	120	60	67	51	71
17M	92	Unc D 8	3	0.55	5.3-7.4	50	64	Failed	Failed				
17B						77	95	78	117	69	77	80	NR
18B	70	Fly ash 30	3	0.55	6.1-7.7	106	100	106	123	88	77	49	68
19T	100	0	4	0.42	6.9-7.9	68	96	69	120	96	79	87	73
19B						67	94	66	135	49	78	Failed	
20T	75	Pumicite 25	4	0.45	5.7-8.5	48	67	51	51	NR	49	Failed	
20M						84	76	84	96	71	86	36	67
20B						97	79	102	115	68	80	89	64
23M	80	Cal sh 20	4	0.45	4.5-6.1	52	66	55	116	55	91	Failed	
23B						52	73	51	94	42	93	67	78
24T	94	Unc D 6	4	0.42	6.5-7.8	75	91	72	116	61	104	61	87
24M						82	93	84	131	94	90	61	81

Core No.	Cementitious Mat'l: Type II Portland Cement %	Cementitious Mat'l: Replacement Material %	Nominal Cement Factor bags/cu yd	Water-Cement Ratio by wt	Air Content %	1978- Readings: 2717 Cycles 1978 %E	2717 Cycles 1978 $\%V^2$	2810 Cycles 1979 %E	2810 Cycles 1979 $\%V^2$
12T	100	0	3	0.55	6.3-7.4	Broken	Broken		
13B	75	Pumicite 25	3	0.58	6.2-7.6	104	73	100	NR
15T	65	Nat cem 35	3	0.56	6.5-8.7	51	79	50	NR
15M						51	†	46	NR
17B	92	Unc D 8	3	0.55	5.3-7.4	90	NR	87	NR
18B	70	Fly ash 30	3	0.55	6.1-7.7	51	65	44	NR
19T	100	0	4	0.42	6.9-7.9	87	68	NR	NR
20M	75	Pumicite 25	4	0.45	5.7-8.5	NR	86	—	NR
20B						121	62	NR	NR
23B	80	Cal sh 20	4	0.45	4.5-6.1	87	71	82	NR
24T	94	Unc D 6	4	0.42	6.5-7.8	65	82	68	NR
24M						67	72	78	NR

† End of specimen too rough to obtain satisfactory reading.
NR Satisfactory reading was not obtained although an attempt was made to obtain one.

(Revised August 1980)

Table 2-CRMI-PD (Continued)

Beach Row 1 (W to E)

Cube No.	Cementitious Mat'l: Type II Portland Cement %	Cementitious Mat'l: Replacement Material[1] %	Nominal Cement Factor bags/cu yd	Water-Cement Ratio by Wt	Air Content %	1970-1976 Readings: 1633 Cycles 1970 %V²	1802 Cycles 1971 %V²	1959 Cycles 1972 %V²	2099 Cycles 1973 %V²	2238 Cycles 1974 %V²	2350 Cycles 1975 %V²	2496 Cycles 1976 %V²
5	100	0	2-1/4	0.73	3.9-6.1	Failed						
7	50	Slag 50	2-1/4	0.76	4.7-6.6	Failed						
8	65	Nat cem 35	2-1/4	0.76	5.7-6.4	Failed						
9	70	Cal sh 30	2-1/4	0.79	5.9-6.3	Failed						
10	88	Unc D 12	2-1/4	0.80	5.5-6.2	†	Failed					
10A	88	Unc D 12	2-1/4	0.80	5.5-6.2	†	Failed					
11	70	Fly ash 30	2-1/4	0.73	5.5-6.2	74	71	60	##	83	51	Failed
11A	70	Fly ash 30	2-1/4	0.73	5.5-6.2	Failed						
12	100	0	3	0.55	6.3-7.4	†	Failed					
13	75	Pumicite 25	3	0.58	6.2-7.6	94	15	NR	##	Failed		
14	50	Slag 50	3	0.60	5.8-6.3	100	82	66	##	65	38	31
15	65	Nat cem 35	3	0.56	6.5-8.7	82	48	49	##	14	NR	NR
16	75	Cal sh 25	3	0.59	5.7-7.4	91	NR	91	##	Failed		
17	92	Unc D 8	3	0.55	5.3-7.4	98	85	77	##	71	NR	NR
18	70	Fly ash 30	3	0.55	6.1-7.7	85	15	Failed				

Cube No.	Cementitious Mat'l: Type II Portland Cement %	Cementitious Mat'l: Replacement Material[1] %	Nominal Cement Factor bags/cu yd	Water-Cement Ratio by Wt	Air Content %	1977- Readings: 2573 Cycles 1977 %V²	2720 Cycles 1978 %V²	2813 Cycles 1979 %V²
14	50	Slag 50	3	0.60	5.8-6.3	Failed		
15	65	Nat cem 35	3	0.56	6.5-8.7	Failed		
17	92	Unc D 8	3	0.55	5.3-7.4	89	103	64
18	70	Fly ash	3	0.55	6.1-7.7	Failed		

† End of specimen too rough to obtain satisfactory reading.

Equipment malfunctioned in 1973.

(Revised August 1980)

Table 1-PQ (Continued)

Section 9

Exposure Rack, Row E, West End

Specimen	Type Cement	Type Water	1969-1973 Observations									
			1969		1970		1971		1972		1973	
			Cycles	Condition	Cycles	Condition	Cycles	Condition	Cycles	Condition	Cycles	Condition
Specimens with Reinforcing Bar												
S-13-R	Aluminous	Sea (normal)	4401	Fair	4554	Fair	4723	Fair	4880	Fair	5020	Fair

Specimen	Type Cement	Type Water	1974-1978 Observations									
			1974		1975		1976		1977		1978	
			Cycles	Condition	Cycles	Condition	Cycles	Condition	Cycles	Condition	Cycles	Condition
S-13-R	Aluminous	Sea (normal)	5159	Fair	5271	Fair*	5417	Fair	5494	Fair	5642	Fair

Specimen	Type Cement	Type Water	1979- Observations	
			1979	
			Cycles	Condition
S-13-R	Aluminous	Sea (normal)	5735	Fair

* Approximately 6 in. sawed off one end in 1975 for laboratory tests by PCA.

(Revised August 1980)

Table 1-SC (Continued)

Beam No.	Mixture No.	Cement/ Aggregate Ratio as Shot (by wt)	Position of Panel When Shot	Type Cement	Fine Aggregate	Reinforcing Mesh	Exposure Rack, Row 5 (W to E) 1975- Readings 1793 Cycles 1975 %E	1939 Cycles 1976 %E	2016 Cycles 1977 %E	2163 Cycles 1978 %E	2256 Cycles 1979 %E
1A	1	1:3.5	Vertical	II, A	Sand A	Yes	96	101	102	NR	NR
1B	1	1:3.5	Vertical	II, A	Sand A	Yes	104	Failed			
2A	2	1:4.0	Vertical	II, A	Sand A	No	123	128	91	NR	NR
2C	2	1:4.0	Vertical	II, A	Sand A	Yes	105	121	107	NR	NR
2D	2	1:4.0	Vertical	II, A	Sand A	Yes	78	81	NR*	NR	NR

* NR denotes a satisfactory reading could not be obtained.

(Revised August 1980)

Table 2-SC

Section 10

Record of Testing of Concrete Beams, Missouri River Division Program

1965- (Installed November 1965)

Exposure Rack, Row 5 (W to E)

Beam No.	Mixture No.	Type Cement	Fine Aggregate	Coarse Aggregate	Air Content %	1965-1972 Readings: 0 Cycles 1965 %E	130 Cycles 1966 %E	286 Cycles 1967 %E	471 Cycles 1968 %E	625 Cycles 1969 %E	778 Cycles 1970 %E	947 Cycles 1971 %E	1104 Cycles 1972 %E
SC-1	6	I, D	Sand D	Gravel A	7.5	100	92	94	100	100	101	96	65
SC-2	6	I, D	Sand D	Gravel A	7.5	100	97	99	96	94	91	73	49
SC-3	6	I, D	Sand D	Gravel A	7.5	100	102	102	100	102	102	80	65

Beam No.	Mixture No.	Type Cement	Fine Aggregate	Coarse Aggregate	Air Content %	1973- Readings: 1244 Cycles 1973 %E	1383 Cycles 1974 %E	1495 Cycles 1975 %E	1641 Cycles 1976 %E	1718 Cycles 1977 %E	1865 Cycles 1978 %E	1958 Cycles 1979 %E
SC-1	6	I, D	Sand D	Gravel A	7.5	89	81	80	82	NR	Failed	
SC-2	6	I, D	Sand D	Gravel A	7.5	NR	Failed					
SC-3	6	I, D	Sand D	Gravel A	7.5	45	NR	NR	NR	NR	NR	Failed

NR denotes no reading was obtained even though an attempt was made to obtain one.

(Revised August 1980)

Table 1-BFS (Continued)

Exposure Rack, Row 5 (W to E)

Beam No.	Cement	1956-1967 Readings: 0 Cycles 1956 %E	144 Cycles 1957 %E	215 Cycles 1958 %E	365 Cycles 1959 %E	436 Cycles 1960 %E	577 Cycles 1961 %E	666 Cycles 1962 %E	772 Cycles 1963 %E	907 Cycles 1964 %E	1070 Cycles 1965 %E	1200 Cycles 1966 %E	1356 Cycles 1967 %E
8ST-128	Type II PC†	100	121	128	130	125	120	120	121	121	118	121	120
8ST-130		100	117	123	125	123	116	114	116	116	114	114	114
8ST-132		100	120	126	126	122	115	114	112	108	108	110	110
8ST-134		100	125	133	134	132	123	125	123	122	118	120	118
8ST-136		100	123	132	132	**							
8ST-138		100	123	129	133	128	120	122	121	115	115	117	115
8ST-140		100	123	130	132	128	120	120	122	120	120	120	119
8ST-142		100	123	130	131	129	119	121	123	118	116	116	116
8ST-144		100	127	135	136	13	124	126	122	122	122	122	123
9ST-146	PBFS* No. 8	100	112	120	120	120	110	115	116	112	112	111	111
9ST-148		100	112	120	120	120	113	111	113	111	111	111	111
9ST-150		100	112	121	122	121	114	116	116	113	113	115	115
9ST-152		100	114	122	124	122	116	117	116	114	113	116	118
9ST-154		100	113	123	123	123	114	116	117	114	114	114	115
9ST-156		100	110	119	119	**							
9ST-158		100	111	117	118	117	107	108	106	103	105	103	104
9ST-160		100	109	116	117	118	110	111	109	107	103	105	105
9ST-162		100	111	118	120	119	110	110	108	106	102	106	106
10ST-164	Blend: No. 2	100	116	124	128	127	120	120	119	118	116	118	117
10ST-166	PBFS, 80%;	100	115	120	123	120	113	115	116	109	109	109	110
10ST-168	nat cem A,	100	107	113	115	111	104	107	103	101	98	91	93
10ST-170	20%††	100	114	121	123	**							
10ST-172		100	113	121	122	122	112	111	111	107	105	103	105
10ST-174		100	110	117	120	117	108	110	108	105	103	100	99
10ST-176		100	112	119	122	119	111	113	111	109	106	106	110
10ST-178		100	111	118	120	118	110	110	111	110	108	106	108
10ST-180		100	111	117	119	117	108	109	107	102	104	101	101
11ST-182	Blend: No. 2	100	109	115	115	113	104	108	102	97	94	92	93
11ST-184	PBFS, 75%;	100	105	110	113	113	101	103	101	94	89	89	89
11ST-186	nat cem A,	100	108	114	116	114	102	105	103	96	94	92	92
11ST-188	25%	100	119	125	129	128	120	121	121	116	119	118	117
11ST-190		100	111	118	120	**							
11ST-192		100	109	117	118	116	106	102	108	106	113	115	117
11ST-194		100	110	118	117	116	104	106	103	95	72	78	77
11ST-196		100	106	114	111	109	93	92	92	83	81	94	93
11ST-198		100	106	113	115	112	101	103	101	95	92	90	90
12ST-200	Blend: No. 2	100	106	110	112	110	100	105	100	95	92	90	90
12ST-202	PBFS, 70%;	100	101	109	109	105	83	95	94	92	89	80	81
12ST-204	nat cem A,	100	99	103	103	101	88	89	89	84	75	72	71
12ST-206	30%	100	100	104	100	100	84	87	78	74	70	62	60
12ST-208		100	102	106	104	104	90	92	85	79	74	69	69
12ST-210		100	111	117	116	116	103	107	103	100	95	97	97
12ST-212		100	113	120	126	121	109	110	110	107	104	101	100
12ST-214		100	117	123	126	124	114	118	118	111	106	104	107
12ST-216		100	120	126	128	**							

Beam No.	Cement	1968-1979 Readings: 1541 Cycles 1968 %E	1695 Cycles 1969 %E	1848 Cycles 1970 %E	2017 Cycles 1971 %E	2174 Cycles 1972 %E	2314 Cycles 1973 %E	2453 Cycles 1974 %E	2565 Cycles 1975 %E	2711 Cycles 1976 %E	2788 Cycles 1977 %E	2935 Cycles 1978 %E	3028 Cycles 1979 %E
1ST-4	PBFS No. 3	109	110	112	112	100	Failed						
1ST-6		120	117	120	121	105	Failed						
1ST-8		112	114	113	114	99	Failed						
1ST-10		113	114	110	103	103	97	97	98	148	116	104	109
1ST-12		111	112	112	111	116	100	102	102	127	NR	NR	Failed
1ST-14		113	114	108	108	110	98	98	100	102	102	112	117
1ST-16		106	102	102	102	101	75	79	79	NR	NR	NR	Failed
1ST-18		105	103	103	109	116	104	150	152	NR	NR	NR	Failed
2ST-20	PBFS No. 4	114	118	116	117	122	122	153	153	NR	NR	NR	Failed
2ST-22		117	121	119	121	123	154	154	160	NR	NR	NR	Failed
2ST-24		120	125	120	122	118	123	118	123	184	191	155	NR
2ST-28		125	123	119	124	123	109	98	100	147	NR	NR	Failed
2ST-30		123	125	118	123	127	110	117	118	122	141	147	NR
2ST-32		125	126	120	128	128	110	111	112	121	156	142	NR
2ST-34		119	120	114	118	116	123	124	128	134	135	135	NR
2ST-36		117	118	114	119	115	119	165	165	NR	NR	NR	Failed

(Continued)

* Portland blast-furnace slag cement.
** Returned to laboratory 1959.
† Portland cement.
†† Nat cem = natural cement.
NR A satisfactory reading was not obtained although an attempt was made to obtain one.

(Revised August 1980)

Table 1-BFS (Continued)

Section 11

Exposure Rack, Row 5 (W to E)

Beam No.	Cement	1968-1979 Readings: 1541 Cycles 1968 %E	1695 Cycles 1969 %E	1848 Cycles 1970 %E	2017 Cycles 1971 %E	2174 Cycles 1972 %E	2314 Cycles 1973 %E	2453 Cycles 1974 %E	2565 Cycles 1975 %E	2711 Cycles 1976 %E	2788 Cycles 1977 %E	2935 Cycles 1978 %E	3028 Cycles 1979 %E
3ST-38	PBFS* No. 1	126	126	124	121	118	97	105	107	NR	NR		
3ST-42		122	123	118	117	115	128	M					
3ST-44		103	102	94	NR	D							
3ST-46		99	98	97	NR	D							
3ST-48		115	116	NR	NR	D							
3ST-50		119	121	114	117	D							
3ST-52		117	118	111	114	D							
3ST-54		126	128	138	NR	D							
4ST-56	PBFS No. 2	125	126	125	128	116	NR	98	98	118	114	118	123
4ST-60		125	126	125	132	NR	NR	NR	NR	D			
4ST-62		113	116	106	113	NR	NR	M	M				
4ST-64		122	122	124	120	NR	NR	NR	NR	D			
4ST-66		120	123	115	116	NR	NR	M	M				
4ST-68		119	119	114	119	NR	NR	M	M				
4ST-70		121	119	110	114	107	140	137	142	136	124	130	133
4ST-72		120	120	113	118	NR	NR	M	M				
5ST-74	PBFS No. 5	106	110	114	111	104	105	107	107	NR	D		
5ST-76		103	104	102	99	92	94	NR	NR	D			
5ST-78		109	107	107	103	97	100	97	99	133	137	142	143
5ST-82		111	111	112	107	104	104	M	M				
5ST-84		108	110	108	99	97	99	100	101	114	113	NR	D
5ST-86		111	109	108	104	102	97	99	99	D			
5ST-88		110	110	107	105	102	96	88	90	96	96	105	106
5ST-90		103	102	102	96	95	70	77	78	100	106		
6ST-92	PBFS No. 6	120	120	120	116	112	101	111	111	106	NR	D	
6ST-96		126	124	125	120	115	114	114	115	NR	NR	D	
6ST-98		120	121	115	110	107	113	113	114	D			
6ST-100		119	118	117	112	110	108	108	111	NR	D		
6ST-102		125	124	124	120	116	117	117	117	NR	D		
6ST-104		116	114	113	110	108	104	104	106	108	112	123	125
6ST-106		117	119	117	112	105	87	NR	NR	D			
6ST-108		117	115	113	106	92	92	93	95	91	NR	NR	D
7ST-112	PBFS No. 7	118	117	117	109	106	105	103	105	103	NR	NR	D
7ST-114		118	116	116	114	106	109	108	110	104	NR		
7ST-116		122	121	119	114	114	109	107	112	110	NR		
7ST-118		125	126	122	116	111	114	113	114	114	NR		
7ST-120		122	118	118	114	107	109	107	112	115	118		
7ST-122		114	114	109	100	100	97	96	98	98	NR		
7ST-124		109	111	107	95	103	92	92	94	92	94		
7ST-126		112	113	111	108	106	103	126	127	130	132		
8ST-128	Type II PC†	118	116	114	114	123	123	118	120	118	119		
8ST-130		114	112	110	116	105	114	114	116	105	115	132	122
8ST-132		106	110	108	109	99	107	107	111	112	117	120	122
8ST-134		120	119	118	113	105	123	121	122	122	124	125	123
8ST-138		117	115	115	111	104	119	116	118	114	117	118	120
8ST-140		119	121	119	107	104	114	132	130	131	121	127	127
8ST-142		116	114	116	112	109	111	119	117	118	119	138	139
8ST-144		121	120	118	114	111	111	118	118	142	146	151	151
9ST-146	PBFS No. 8	112	110	108	106	102	112	114	114	NR	D	D	D
9ST-148		113	111	111	109	105	116	119	118				
9ST-150		117	116	114	116	112	119	120	120				
9ST-152		116	114	114	114	123	118	174	160				
9ST-154		113	110	112	112	121	139	NR	NR				
9ST-158		101	100	100	100	115	83	NR	NR				
9ST-160		105	105	103	101	109	88	NR	NR				
9ST-162		106	104	105	107	116	104	105	105				
10ST-164	Blend: No. 2	114	116	114	106	NR	96	100	102				
10ST-166	PBFS, 80%;	102	100	98	108	109	93	96	96				
10ST-168	nat cem A,	82	82	83	92	85	85	NR	NR				
10ST-172	20%††	101	101	101	74	D							
10ST-174		99	101	99	103	97	101	102	102				
10ST-176		106	104	102	103	96	76	91	89				
10ST-178		102	103	101	97	95	80	NR	NR				
10ST-180		93	91	91	Broken								

(Continued)

* Portland blast-furnace slag cement.

† Portland cement.

†† Nat cem = natural cement.

NR A satisfactory reading was not obtained although an attempt was made to obtain one.

D Specimens so deteriorated that no reading can be obtained.

M Missing.

(Sheet 3)

(Revised August 1980)

Table 1-SSFE

Section 12

Record of Testing of Concrete Specimens for Specimen Size-Frost Effects Investigation

1968- (Installed Dec 1968)

Exposure Rack

Specimen No.	Air Content* %	1968-1975 Readings: 0 Cycles, 1968 Pulse Veloc fps		139 Cycles 1969		292 Cycles 1970		461 Cycles 1971		618 Cycles 1972		758 Cycles 1973		897 Cycles 1974		1009 Cycles 1975	
		%E	%V²	%E	%V²	%E	%V²	%E	%V²	%E	%V²	%E	%V²	%E	%V²	%E	%V²
3-1/2- by 4-1/2- by 16-in. Beams																	
ROS-4A	4.3	100	15,465	102	107	107	100	118	91	118	102	115	96	116	119	116	80
ROS-4B	4.3	100	15,930	104	99	110	96	119	82	119	96	117	94	118	110	118	57
ROS-4C	4.3	100	16,420	101	95	108	89	119	78	119	89	119	93	118	105	119	64
ROS-5A	4.6	100	15,740	102	104	108	101	118	86	120	94	121	101	120	95	118	66
ROS-5B	4.6	100	16,420	100	100	109	93	119	79	117	85	117	103	118	111	118	70
ROS-5C	4.6	100	16,420	100	99	110	91	120	83	118	91	118	98	119	105	118	70
ROS-6A	4.2**	100	16,120	100	101	111	94	119	84	117	96	117	96	116	105	117	73
ROS-6B	4.2**	100	16,320	100	100	110	88	118	75	116	90	118	99	120	103	120	70
ROS-6C	4.2**	100	16,320	100	101	110	84	117	75	115	84	120	104	119	105	120	67
6- by 6- by 30-in. Beams																	
ROS-1	4.0	100	14,795	100	100	114	115	112	111	92	109	99	109	112	109	127	109	152
ROS-2	4.4**	100	14,705	100	102	116	126	111	121	90	118	99	116	101	118	123	116	150
ROS-3	4.8	100	15,335	100	100	105	108	104	101	81	102	98	104	98	104	113	104	130
2-ft Cubes																	
ROS-1	4.0	100	15,210	100	†	101	†	99	†	82	†	101	†	102	†	119	†	150
ROS-2	4.4**	100	15,265	100	†	100	†	94	†	78	†	93	†	103	†	112	†	141
ROS-3	4.8	100	15,150	100	†	100	†	97	†	80	†	100	†	97	†	110	†	106
18- by 18- by 36-in. Prisms																	
ROS-4	4.3	100	15,750	100	94	102	106	99	107	89	105	95	108	105	109	105	109	109
ROS-5	4.6	100	15,545	100	94	102	102	100	114	87	116	99	116	105	116	108	116	111
ROS-6	4.2**	100	15,425	100	97	103	108	100	108	90	108	101	108	111	108	108	108	109

Specimen No.	Air Content* %	1976- Readings: 1155 Cycles 1976		1232 Cycles 1977		1379 Cycles 1978		1472 Cycles 1979	
		%E	%V²	%E	%V²	%E	%V²	%E	%V²
3-1/2- by 4-1/2- by 16-in. Beams									
ROS-4A	4.3	113	113	113	91	113	104	113	22
ROS-4B	4.3	116	105	116	87	117	95	118	21
ROS-4C	4.3	121	100	117	85	118	89	119	20
ROS-5A	4.6	102	116	114	87	121	93	121	21
ROS-5B	4.6	119	105	120	89	121	89	119	20
ROS-5C	4.6	121	100	120	87	121	87	122	20
ROS-6A	4.2**	118	98	117	93	117	89	118	21
ROS-6B	4.2**	115	100	117	89	108	81	113	19
ROS-6C	4.2**	117	105	117	70	108	86	113	19
6- by 6- by 30-in. Beams									
ROS-1	4.0	109	119	107	116	109	114	104	119
ROS-2	4.4**	112	114	119	116	116	111	112	119
ROS-3	4.8	100	100	102	101	102	105	96	101
2-ft Cubes									
ROS-1	4.0	†	112	†	112	†	105	†	106
ROS-2	4.4**	†	100	†	106	†	91	†	103
ROS-3	4.8	†	102	†	108	†	97	†	98
18- by 18- by 36-in. Prisms									
ROS-4	4.3	106	108	107	103	99	105	107	107
ROS-5	4.6	118	110	118	106	120	110	118	107
ROS-6	4.2**	112	110	112	104	110	189	108	114

* Air content d ained on each batch; six batches of concrete were made for this investigation.

** Slump was 2-1/ in. for these batches; slump of all other batches of concrete was 2 in.

† Unable to obtain satisfactory flexural frequency reading on these cubes.

(Revised August 1980)

Table 1-TP

Section 1?

Record of Testing of Trumbu'l Pond Dam Concrete Prisms

1972- (Installed June 1972)

Exposure Rack, Row 3

Prism No.	Replacement Material	Water-Cement Ratio by Wt	Cementitious Material, lb/cu yd: Type II Portland Cement	Cementitious Material, lb/cu yd: Fly Ash	1972-1975 Readings: 0 Cycles, 1972: %E	0 Cycles, 1972: Pulse Velocity fps	0 Cycles, 1972: $\%V^2$	140 Cycles 1973: %E	140 Cycles 1973: $\%V^2$	276 Cycles 1974: %E	276 Cycles 1974: $\%V^2$	388 Cycles 1975: %E	388 Cycles 1975: $\%V^2$
Cem-1	None	0.66	273	0	100	13,760	100	113	111	113	103	109	98
Cem-2	None	0.66	273	0	100	13,890	100	117	101	115	106	114	127
Cem-3	None	0.66	273	0	100	14,220	100	101	108	100	105	99	126
FA-1	Fly ash*	0.63	192	79	100	13,335	100	118	103	113	108	108	107
FA-2	Fly ash*	0.63	192	79	100	13,275	100	125	116	121	106	116	98
FA-3	Fly ash*	0.63	192	79	100	13,335	100	120	92	106	58	106	End gone

Prism No.	Replacement Material	Water-Cement Ratio by Wt	Cementitious Material, lb/cu yd: Type II Portland Cement	Cementitious Material, lb/cu yd: Fly Ash	1976- Readings: 534 Cycles 1976: %E	534 Cycles 1976: $\%V^2$	611 Cycles 1977: %E	611 Cycles 1977: $\%V^2$	758 Cycles 1978: %E	758 Cycles 1978: $\%V^2$	851 Cycles 1979: %E	851 Cycles 1979: $\%V^2$
Cem-1	None	0.66	273	0	75	NR	NR	NR	Failed			
Cem-2	None	0.66	273	0	109	102	77	106	NR	104	NR	106
Cem-3	None	0.66	273	0	100	91	47	97	NR	105	NR	88
FA-1	Fly ash*	0.63	192	79	119	NR	62	NR	Failed			
FA-2	Fly ash*	0.63	192	79	106	NR	NR	NR	Failed			
FA-3	Fly ash*	0.63	192	79	--	--	--	--	Failed			

* 35 percent replacement by solid volume; all prisms contain type II portland cement.
NR denotes a satisfactory reading could not be obtained.

(Revised August 1980)

Table 1-4.5A

Section 14

Record of Testing of Prisms Made for Investigation of 4-1/2-in. Aggregate Concrete

1968- (Installed Dec 1968)

Exposure Rack, Row 2

Prism No.	Date Made	Replacement Material	Water-Cement Ratio by Wt	Cement Factor bags/cu yd	1968-1972 Readings: 0 Cycles, 1968 %E	0 Cycles, 1968 Pulse Veloc fps	0 Cycles, 1968 %V²	139 Cycles 1969 %E	139 Cycles 1969 %V²	292 Cycles 1970 %E	292 Cycles 1970 %V²	461 Cycles 1971 %E	461 Cycles 1971 %V²	618 Cycles 1972 %E	618 Cycles 1972 %V²
Mix 1, Rd 1	Oct 1967	None	0.8	2.30	100	16,130	100	87	102	106	99	105	73	91	62
Rd 2	Oct 1967	None	0.8	2.30	100	16,130	100	96	101	105	99	104	61	91	NR**
Mix 2, Rd 1	Nov 1967	None	0.9	2.04	100	15,705	100	99	103	102	100	101	83	89	81
Rd 2	Dec 1967	None	0.9	2.04	100	16,045	100	99	99	91	92	87	66	NR	43
Mix 3, Rd 1	Apr 1968	None	1.0	1.84	100	15,705	100	95	103	88	95	83	69	82	NR
Rd 2	July 1968	None	1.0	1.84	100	15,750	100	97	103	110	99	109	75	Failed	NR
Mix 4, Rd 1	Apr 1968	Fly ash*	0.8	2.40	100	16,440	100	93	104	122	98	108	76	110	86
Rd 2	July 1968	Fly ash*	0.8	2.40	100	16,045	100	89	99	120	96	116	79	111	91
Mix 5, Rd 1	June 1968	Fly ash*	0.9	2.14	100	15,790	100	95	111	106	107	106	86	99	96
Rd 2	July 1968	Fly ash*	0.9	2.14	100	15,665	100	90	108	103	105	103	84	100	65
Mix 6, Rd 1	July 1968	Fly ash*	1.0	1.94	100	15,625	100	101	102	65	97	Failed	78	Failed	58
Rd 2	July 1968	Fly ash*	1.0	1.94	100	15,545	100	97	107	105	96	103	75	84	84

Prism No.	Date Made	Replacement Material	Water-Cement Ratio by Wt	Cement Factor bags/cu yd	1973-1977 Readings: 758 Cycles 1973 %E	758 Cycles 1973 %V²	894 Cycles 1974 %E	894 Cycles 1974 %V²	1006 Cycles 1975 %E	1006 Cycles 1975 %V²	1152 Cycles 1976 %E	1152 Cycles 1976 %V²	1229 Cycles 1977 %E	1229 Cycles 1977 %V²
Mix 1, Rd 1	Oct 1967	None	0.8	2.30	77	86	75	61	72	67	93	14	90	18
Rd 2	Oct 1967	None	0.8	2.30	NR	--	Failed							
Mix 2, Rd 1	Nov 1967	None	0.9	2.04	92	92	NR	98	Failed					
Rd 2	Dec 1967	None	0.9	2.04	Failed									
Mix 3, Rd 1	Apr 1968	None	1.0	1.84	NR	NR	Failed							
Rd 2	July 1968	None	1.0	1.84	Failed	NR								
Mix 4, Rd 1	Apr 1968	Fly ash*	0.8	2.40	101	98	92	92	92	95	95	37	--	Failed
Rd 2	July 1968	Fly ash*	0.8	2.40	107	103	100	96	100	108	Failed			
Mix 5, Rd 1	June 1968	Fly ash*	0.9	2.14	95	111	86	103	86	111	66	50	73	48
Rd 2	July 1968	Fly ash*	0.9	2.14	93	104	87	105	81	107	79	11	Failed	
Mix 6, Rd 1	July 1968	Fly ash*	1.0	1.94	Failed	95	Failed							
Rd 2	July 1968	Fly ash*	1.0	1.94	73	93	NR	78	Failed					

Prism No.	Date Made	Replacement Material	Water-Cement Ratio by Wt	Cement Factor bags/cu yd	1978 Readings: 1376 Cycles 1978 %E	1376 Cycles 1978 %V²
Mix 1, Rd 1	Oct 1967	None	0.8	2.30	Failed	
Mix 5, Rd 1	June 1968	Fly ash*	0.9	2.14	Failed	

* 30% replacement by solid volume; all prisms contain type II portland cement.
** NR denotes a satisfactory reading could not be obtained.

(Revised August 1980)

Table 1-SIC

Section 15

Sulfur-Infiltrated Concrete Specimens (Installed August 1976)

Exposure Rack, Row 9

Specimen No.	1976- Readings			
	0 Cycles, 1976 Pulse Veloc, fps	77 Cycles, 1977 fv^2	224 Cycles, 1978 fv^2	317 Cycles, 1979 fv^2
			4- x 8-in. Cylinders	
81-6	14,620	96	102	77
82-6	15,360	89	97	70
83-6	15,360	93	78	65
84-6	15,505	87	91	71
85-6	16,500	79	77	58
86-6	14,185	80	88	43
87-6	15,875	83	87	68
88-6	15,505	86	91	68
89-6	16,105	85	81	71
81-7	15,150	88	88	66
82-7	16,835	77	74	60
83-7	15,360	89	97	60
84-7	15,875	87	81	51
85-7	16,665	81	76	67
86-7	13,550	101	89	63
87-7	16,180	78	88	68
88-7	15,505	87	91	66
89-7	16,025	85	78	69
			3- x 6-in. Cylinders	
81-7	15,150	110	106	84
81-8	14,880	120	146	106
81-9	14,970	109	109	86
81-10	15,060	108	131	69
82-7	15,245	108	105	73
82-8	15,430	106	117	86
82-9	15,625	107	89	79
82-10	15,625	107	89	79
83-7	15,060	108	108	66
83-8	15,245	105	93	93
83-9	15,335	104	98	74
83-10	15,245	102	99	88
84-7	15,245	112	112	88
84-8	15,825	98	111	82
84-9	15,825	111	98	92
84-10	15,430	109	91	91
85-7	15,825	104	98	59
85-8	15,430	109	86	91
85-9	15,430	109	109	73
85-10	15,060	115	95	69
86-7	13,890	112	119	106
86-8	14,285	106	136	95
86-9	14,970	97	109	77
86-10	14,795	112	112	88
87-7	15,150	110	100	72
87-8	14,705	117	100	94
87-9	14,705	117	128	80
87-10	14,705	109	113	72
88-7	14,970	109	102	60
88-8	14,880	120	100	100
88-9	14,705	109	113	100
88-10	14,880	120	120	106
89-7	14,880	113	120	81
89-8	14,970	102	102	97
89-9	14,795	102	111	--
89-10	14,970	102	--	--

Table 1-RCC

Record of Testing for Roller Compacted Concrete

(Installed at Treat Island in August 1977)

Exposure Rack, Row 6

Beam No.	0 Cycles, 1977 %E	0 Cycles, 1977 Pulse Velocity fps	0 Cycles, 1977 $\%V^2$	1977-147 Cycles, 1978 Readings %E	1977-147 Cycles, 1978 Readings Pulse Velocity fps	1977-147 Cycles, 1978 Readings $\%V^2$
17257-7	100	13,160	100		Failed	
17257-8	100	12,930	100			
17257-9	100	13,045	100			
17258-7	100	14,020	100			
17258-8	100	14,150	100			
17258-9	100	14,425	100			

(Installed at Treat Island in July 1955)

Specimen No.	Cement Type	Cement Program No.	2729 Cycles 1975 %E	2729 Cycles 1975 $\%V^2$	2875 Cycles 1976 %E	2952 Cycles 1977 %E	3099 Cycles 1978 %E	3192 Cycles 1979 %E
			1975- Readings					
5693C	IV	43A*	125	‡	137	Failed		
5694C			121	‡	121	135	136	149
5695C			105	‡	123	95	100	110
5696C	II	21	102	‡	113	97	NR	NR
5697C			112	‡	136	112	123	123
5698C			100	‡	100	117	110	123
5699C	IV	41**	110	‡	107	108	NR	117
5700C			111	‡	108	128	130	131
5701C			106	‡	107	107	113	113
5702C	I	16	97	‡	106	122	133	131
5703C			96	‡	101	102	105	112
5704C			112	‡	112	117	122	122
5705C	V	51	98	‡	121	121	133	137
5706C			95	‡	100	68	68	72
5707C			69	‡	88	88		
5708C	I	13	93	‡	99	91	89	99
5709C			101	‡	102	99	106	111
5710C			114	‡	114	125	123	123
5711C	I	11	126	‡	128	139	145	143
5712C			127	‡	130	136	154	146
5713C			132	‡	132	147	153	159
5714C	II	23	135	‡	137	139	151	138
5715C			128	‡	129	136	150	153
5716C			129	‡	122	142	138	142
5717C	II	25†	136	‡	134	150	151	148
5718C			130	‡	132	143	136	154
5719C			126	‡	126	133	141	141
5720C	I	19B	125	‡	127	133	142	142
5721C			130	‡	137	138	149	149
5722C			127	‡	128	135	NR	NR
5723C	I	19C	136	‡	137	137	149	160
5724C			139	‡	139	140	128	132
5725C			130	‡	130	133	140	140
5726C	I	12††	132	‡	137	137	143	136
5727C			131	‡	132	130	139	137
5728C			133	‡	133	130	143	164
5729C	I	17	128	‡	128	130	136	138
5730C			130	‡	131	130	128	132
5731C			118	‡	122	Failed		
5732C	III	31††	144	‡	Failed			
5733C			154	‡	154	Failed		
5734C			156	‡	156	Failed		
5735C	I	15	131	‡	133	Failed		
5736C			106	‡	110	Failed		
5737C			110	‡	125	110	118	117
5738C	II	22††	117	‡	118	129	117	117
5739C			132	‡	134	132	132	
5740C			136	‡	136	Failed		

(Continued)

* Cements 43 and 43A made at same plant.
** Cements 14, 24, and 41 made at same plant.
† Cements 25 and 33 made from some major raw materials.
†† Cements 12, 22, and 31 made at same plant.
‡ End of specimen too rough to obtain satisfactory reading. $\%V^2$ data discontinued.

Table 1-LTS (Continued) Section 17

(Installed at Treat Island in July 1955)

Specimen No.	Cement Type	Cement Program No.	1975- Readings: 2729 Cycles 1975 %E	2729 Cycles 1975 $\%V^2$	2875 Cycles 1976 %E	2952 Cycles 1977 %E	3099 Cycles 1978 %E	3192 Cycles 1979 %E
5741C	III	33†	147	*	150	Failed		
5743C			139	*	113	140	NR	NR
5744C	I	14**	115	*	114	144	150	148
5745C			119	*	121	119	137	137
5746C			Missing					
5747C	II	24**	124	*	123	124	119	142
5748C			118	*	119	134	146	144
5749C			113	*	117	117	108	108
5750C	I	19A	129	*	130	135	139	140
5751C			127	*	132	132	139	139
5752C			131	*	133	133	145	155
5753C	I	18	107	*	Failed			
5754C			115	*	Failed			
5755C			134	*	Failed			
5756C	IV	43*	133	*	Failed			
5757C			123	*	123	Failed		
5758C			128	*	128	130	128	129
5759C	II	22††	112	*	112	127	133	134
5760C			131	*	133	141	174	165
5761C			134	*	139	135	141	142
5762C	IV	43*	120	*	122	120	126	134
5763C			132	*	133	132	138	136
5764C			125	*	125	125	NR	NR
5765C	II	25†	129	*	130	128	136	135
5766C			124	*	126	Failed		
5767C			124	*	124	126	126	127
5768C	II	23	118	*	120	119	126	132
5769C			119	*	120	119	136	136
5770C			133	*	133	122	126	127
5771C	I	17	116	*	116	116	133	131
5772C			126	*	124	120	126	124
5773C			110	*	112	112	NR	
5774C	IV	43A*	130	*	128	160	160	154
5775C			133	*	134	137	133	131
5776C			142	*	141	142	162	160
5777C	I	16	124	*	132	133	NR	
5778C			119	*	120	115	124	122
5779C			130	*	124	123	152	150
5780C	III	31††	136	*	Failed			
5781C			163	*	Failed			
5782C			160	*	Failed			
5783C	III	33†	157	*	Failed			
5784C			155	*	Failed			
5785C			156	*	Failed			
5786C	I	12††	107	*	110	110	156	150
5787C			111	*	115	117	122	122
5788C			117	*	117	122	138	136
5789C	I	19B	129	*	130	112	117	118
5790C			130	*	125	133	142	141
5791C			119	*	119	114	121	121
5792C	I	19C	131	*	130	126	129	127
5793C			101	*	103	103	103	104
5794C			128	*	132	133	144	163

(Continued)

* Cements 43 and 43A made at same plant.
** Cements 14, 24, and 41 made at same plant.
† Cements 25 and 33 made from same major raw materials.
†† Cements 12, 22, and 31 made at same plant.
* End of specimen too rough to obtain satisfactory reading. $\%V^2$ data discontinued.

(Installed at Treat Island in July 1955)

Specimen No.	Cement Type	Cement Program No.	2729 Cycles 1975 %E	2729 Cycles 1975 $\%V^2$	2875 Cycles 1976 %E	2952 Cycles 1977 %E	3099 Cycles 1978 %E	3192 Cycles 1979 %E
					1975– Readings			
5795C	I	14**	135	*	130	128	130	137
5796C			112	*	113	155	NR	NR
5797C			107	*	106	107	109	110
5798C	I	11	125	*	119	129	137	135
5799C			142	*	142	142	152	166
5800C			141	*	146	130	148	148
5801C	II	21	124	*	122	124	132	131
5802C			112	*	113	115	141	141
5803C			116	*	116	116	121	121
5804C	V	51	116	*	116	120	126	139
5805C			115	*	115	Failed		
5806C			99	*	103	108	113	113
5807C	I	18	112	*	115	116	114	112
5808C			142	*	152	147	147	144
5809C			120	*	123	111	126	132
5810C	II	24**	102	*	108	107	112	118
5811C			95	*	104	103	156	120
5812C			125	*	126	128	133	131
5813C	I	13	123	*	116	114	111	112
5814C			94	*	102	102	126	126
5815C			122	*	124	125	137	124
5816C	IV	41**	125	*	126	127	134	134
5817C			115	*	116	117	119	119
5818C			120	*	117	119	127	130
5819C	I	19A	119	*	117	116	128	126
5820C			135	*	137	137	125	141
5821C			130	*	129	Failed		
5822C	I	15	117	*	115	Failed		
5823C			119	*	125	97	121	119
5824C			131	*	136	132	120	121
5825C	I	19C	130	*	135	130	153	139
5826C			126	*	126	129	126	127
5827C			138	*	143	143	138	144
5828C	I	11	116	*	114	113	130	129
5829C			130	*	137	130	130	128
5830C			120	*	123	124	123	123
5831C	I	19A	117	*	121	Failed		
5832C			129	*	129	130	129	140
5833C			120	*	139	128	126	126
5834C	IV	43A*	119	*	122	Failed		
5835C			122	*	127	Failed		
5836C			118	*	126	Failed		
5837C	I	18	124	*	130	Failed		
5838C			153	*	166	155	126	129
5839C			115	*	121	132	132	135
5840C	I	15	124	*	Failed			
5841C			122	*	Failed			
5842C			114	*	Failed			
5843C	III	33†	125	*	Failed			
5844C			148	*	Failed			
5845C			141	*	Failed			
5846C	IV	43*	131	*	Failed			
5847C			90	*	Failed			
5848C			91	*	Failed			

(Continued)

* Cements 43 and 43A made at same plant.
** Cements 14, 24, and 41 made at same plant.
† Cements 25 and 33 made from same major raw materials.
* End of specimen too rough to obtain satisfactory reading. $\%V^2$ data discontinued.

(Revised August 1980)

Table 1-LTS (Continued) Section 17

(Installed at Treat Island in July 1955)

Specimen No.	Cement Type	Cement Program No.	2729 Cycles 1975 %E	2729 Cycles 1975 SV^2	2875 Cycles 1976 %E	2952 Cycles 1977 %E	3099 Cycles 1978 %E	3192 Cycles 1979 %E
					1975- Readings			
5849C	I	16	119	*	124	118	90	94
5850C			127	*	127	129	131	133
5851C			114	*	115	114	143	148
5852C	I	13	106	*	103	101	121	121
5853C			119	*	120	120	154	147
5854C			123	*	131	134	140	140
5855C	III	31††	155	*	166	158	145	142
5856C			123	*	Failed			
5857C			162	*	178	Failed		
5858C	II	24**	127	*	132	132	127	127
5859C			121	*	122	Failed		
5860C			70	*	62	128	117	116
5861C	I	14**	96	*	91	97	107	110
5862C			116	*	115	117	116	117
5863C			115	*	118	105	113	114
5864C	II	23	114	*	117	114	119	112
5865C			77	*	79	77	MR	MR
5866C			97	*	102	Failed		
5867C	II	21	108	*	110	112	MR	MR
5868C			112	*	116	118	119	122
5869C			*	*	Failed			
5870C	I	19B	114	*	117	124	126	126
5871C			120	*	125	127	108	108
5872C			99	*	107	109	97	98
5873C	I	12††	87	*	92	92	102	101
5874C			109	*	112	112	115	117
5875C			127	*	123	124	119	141
5876C	V	51	125	*	127	127	126	130
5877C			88	*	95	Failed		
5878C			123	*	126	128	126	126
5879C	IV	41**	121	*	124	125	118	120
5880C			113	*	114	114	120	113
5881C			106	*	115	135	117	128
5882C	I	17	114	*	112	112	128	127
5883C			125	*	123	123	123	123
5884C			123	*	124	125	146	140
5885C	II	25†	114	*	114	146	134	113
5886C			115	*	113	119	119	119
5887C			134	*	135	136	126	124
5888C	II	22††	132	*	135	134	132	132
5889C			117	*	120	152	128	127
5890C			130	*	133	158	138	146

** Cements 14, 24, and 41 made at same plant.
† Cements 25 and 33 made from same major raw materials.
†† Cements 12, 22, and 31 made at same plant.
* End of specimen too rough to obtain satisfactory reading. SV^2 data discontinued.

Table 1-NED

Record of Testing of Concrete Specimens from Charles River Dam, and Smelt Brook Local Protection Project (Installed August 1976)

Exposure Rack, Row 3

	1976- Readings								
	0 Cycles 1976			77 Cycles 1977		224 Cycles 1978		317 Cycles 1979	
Beam No.	%E	Pulse Veloc fps	$\%V^2$	%E	$\%V^2$	%E	$\%V^2$	%E	$\%V^2$
1	100	16,000	100	100	98	118	103	109	98
2	100	16,130	100	106	97	111	110	111	98
3	100	16,000	100	107	98	107	105	105	102
4	100	17,240	100	113	88	117	98	113	93
5	100	17,700	100	108	89	111	95	111	93
6	100	17,240	100	115	95	109	83	107	86
7	100	16,130	100	107	91	109	102	111	92
8	100	16,260	100	106	97	105	102	107	105
9	100	15,750	100	105	105	105	120	114	100
10	100	16,130	100	116	97	109	107	110	98
11	100	16,530	100	112	91	112	101	112	94
12	100	16,000	100	111	95	111	100	113	100
13	100	15,750	100	108	97	109	105	108	102
14	100	15,875	100	105	97	106	100	106	100
15	100	15,750	100	107	98	108	101	106	103
16	100	15,875	100	105	98	106	106	104	100
17	100	16,130	100	99	95	108	100	102	100
18	100	16,260	100	107	95	109	98	106	100

(Issued August 1980) Key to Section 19

Concrete-Polymer Materials

In text:

Aggregates: Coarse, natural gravel, Clear Creek
Fine, natural sand, Clear Creek

Cement: Type II blended (Lab. No. M-6800)

PIC Catalyst: D-A79

Vinyl Ester Resin: Dow Derakane 470

Concrete-Polymer Materials

In July 1978 twelve 6- by 6- by 30-in. beams were installed at half-tide elevation for the Water and Power Resource· Service (formerly USBR) to investigate the durability and performance of polymer and polymer-impregnated concrete. The polymer concrete specimens represent two mixtures, one using methyl methacrylate (MMA), and one using vinyl ester (VE). The polymer-impregnated specimens are portland cement concrete (PCC) that was impregnated with MMA by vacuum and pressure soak. The program also includes control specimens of portland cement concrete with no treatment.

Table 1 contains pertinent data on mixture designs. Table 1-CPM contains the exposure records of the specimens to date.

(Issued August 1980) Section 19

Table 1

Mixture Design Data

WPRS Concrete Specimens for Tests at Treat Island, Maine

Material	Design Data
Portland Cement Concrete (PCC)	Aggregate - natural sand and gravel Gravel - 57 percent, 3/4-in. maximum size Sand - 43 percent Cement - Type II blended laboratory cement, 672 lb/yd^3 Water/Cement ratio - 0.43 Slump - 3 in. Entrained air - 3 percent 28 day fog cure Compressive strength - 6000 lb/in.^{2}
Polymer Impregnated Concrete (PIC)	PIC specimens made from the PCC specimens Full impregnation (vacuum and pressure soak Monomer - MMA Polymer loading - 5.3 percent Catalyst - 0.5 percent
Polymer Concrete (PC)	Aggregate - same as PIC and PCC MMA - PC Monomer - 7 percent (97.5 percent MMA + 2.5 percent TMPTMA) Catalyst - 1.5 percent BP Promoter - 0.5 percent DMA Coupling agent - 0.5 percent silane VE - PC Resin - 7.5 percent vinyl ester Catalyst - 1.5 percent MEKP Promoter - 0.5 percent CoN Coupling agent - 0.5 percent silane

Table 1-[illegible]

Record of Testing for Con[illegible]ete-Polymer Materials

(Installe[illegible] July 1978)

Exposure Rack, Row 7

Beam No.	0 Cycles 1978 %E	0 Cycles 1978 Pulse Veloc fps	0 Cycles 1978 $\%V^2$	93 Cycles 1979 %E	93 Cycles 1979 $\%V^2$
			1978- Readings		
PCC - 1	100	13,965	100	109	98
2	100	13,965	100	106	99
3	100	13,965	100	102	99
PIC - 1	100	16,130	100	158	87
2	100	16,130	100	158	84
3	100	16,130	100	156	85
MMA - 1	100	15,245	100	91	93
2	100	15,335	100	98	94
3	100	15,530	100	98	90
VE - 1	100	13,660	100	152	96
2	100	13,515	100	1[illegible]3	93
3	100	13,660	100	154	91

(Issued August 1980) Key to Section 20

Cement Replacement and High-Range Water-Reducing Admixtures

In text and tables:

Aggregates: The aggregates were supplied by Brunswick Ready-Mix Concrete, Ltd., Aggregate Division, P. O. Box 270, Grand Bay, New Brunswick, from their Blagdon Pit.

Air-entraining admixture: The air entraining agent was supplied by W. R. Grace & Co., Ltd., 66 Hymus Rd., Scarborough, Ontario, in a plastic container labeled "Darex AEA Liquid." This material was supplied by this firm in response to a request for a sulphonated hydrocarbon, type A.E.A.

Cement: The cement was supplied by Canada Cement Lafarge, Ltd.

Slag: The slag was delivered in metal drums from Standard Ind., Hamilton, Ontario.

High-Range water reducers: "A" - Mighty 150, Atlas Chemicals, Brantford, Ontario.
"B" - Melment L10, Sternson, Ltd., Brantford, Ontario.

Cement Replacement and High-Range Water-Reducing Admixtures

In October 1978 concrete specimens from a Canadian research program were installed at Treat Island to investigate the effect of cement replacement with slag and the effect of high-range water reducers on the durability and performance of concrete exposed to severe weathering in a marine environment. There has been a discussion of the possibility that the construction of marine structures in the Maritime Provinces could possibly benefit from the slag and fly ash being produced in these areas. It is intended that the exposure tests will identify the possible benefits from the use of these materials. The program will also provide data on the effect of recently developed high-range water-reducing admixtures.

The variables include three water-cement ratios, two types of portland cement with or without slag replacement and with or without air entrainment, and the use of two high-range water reducers.

Tables 1-4 give information on the concrete mixture, the proportioning, properties of the freshly mixed concrete, and aggregate gradings. Tables 1-CR and 2-CR are records of testing of the concrete prisms and cylinders over the years.

Table 1

Concrete Mixture Description

Series	% Slag*	Cement Type**	Water to Cement Ratio
A01	0	10	0.4
02	25	10	0.4
03	25	10	0.4
04	25	10	0.4
05	0	10	0.4
06	45	10	0.4
07	45	10	0.4
08	45	10	0.4
09	0	10	0.4
10	65	10	0.4
11	65	10	0.4
12	65	10	0.4
13	0	50	0.4
14	0	50	0.4
15	0	10	0.4
B01	0	10	0.5
02	25	10	0.5
03	25	10	0.5
04	25	10	0.5
05	0	10	0.5
06	45	10	0.5
07	45	10	0.5
08	45	10	0.5

(Continued)

* By weight.

** U. S. equivalent to cement type 10 and cement type 50 are type I and type V respectively.

Table 1 (Continued)

Series	% Slag	Cement Type	Water to Cement Ratio
B09	0	10	0.5
10	65	10	0.5
11	65	10	0.5
12	65	10	0.5
13	0	50	0.5
14	0	50	0.5
15	0	10	0.5
C01	0	10	0.6
2	25	10	0.6
3	25	10	0.6
4	25	10	0.6
5	0	10	0.6
6	45	10	0.6
7	45	10	0.6
8	45	10	0.6
9	0	10	0.6
10	65	10	0.6
11	65	10	0.6
12	65	10	0.6
13	0	50	0.6
14	0	50	0.6
15	0	10	0.6

(Continued)

Table 1 (Concluded)

Series	% Slag	Cement Type	Water to Cement Ratio
1	0	10	0.5
2AMI	0	10	0.5
3MI	0	10	0.5
4	0	10	0.5
5AME	0	10	0.5
6ME	0	10	0.5

Table 2

Properties of Fresh Concrete

Series	Slump, in.	Air Content, %	Unit weight, lb/ft^3
A01	2-3/4	5.6	146.2
2	2-1/4	7.0	143.8
3	3-1/2	6.6	143.2
4	3-5/8	6.8	142.4
5	3-1/2	6.5	145.1
6	2-7/8	6.8	144.6
7	2-1/4	6.4	144.2
8	2-3/8	6.5	144.5
9	3-5/8	5.8	145.3
10	2-1/4	6.0	144.1
11	3	6.4	140.7
12	3	6.4	141.1
13	2-3/4	6.2	146.5
14	2-5/8	5.6	147.4
15	3	5.5	145.9
B01	3-1/2	6.5	143.7
2	3-7/8	6.7	142.8
3	3-5/8	5.9	144.2
4	3-3/8	5.5	145.0
5	3-3/8	5.5	148.2
6	3	6.4	144.1
7	2-3/4	6.8	143.9
8	2-7/8	6.2	144.3

(Continued)

Table 2 (Continued)

Series	Slump, in.	Air Content, %	Unit weight, lb/ft^3
B09	3	6.5	146.3
10	3	7.0	143.9
11	2-1/2	5.6	145.1
12	2-7/8	5.5	146.3
13	3-3/8	6.2	145.7
14	3-1/2	6.5	145.1
15	3-3/8	6.5	144.6
C01	3-1/2	5.8	147.5
2	3-7/8	6.4	145.5
3	4	5.5	145.7
4	3-1/2	5.9	147.3
5	3	5.7	145.1
6	3	5.2	145.3
7	3-1/2	6.5	143.2
8	3-3/4	6.2	143.4
9	3-1/2	5.4	144.6
10	3-5/8	5.5	144.6
11	3-5/8	6.2	144.2
12	3-5/8	5.2	145.8
13	3-7/8	5.4	147.8
14	4	5.3	148.2
15	3-7/8	6.0	145.7

(Continued)

Table 2 (Concluded)

Series	Slump, in.	Air Content, %	Unit weight, lb/ft^3
1	3-1/4	5.6	146.0
2 AMI	Collapse	6.3	144.8
3 MI	Collapse	0.9	152.2
4	2-3/8	1.5	152.3
5 AME	Collapse	6.2	144.4
6 ME	Collapse	0.3	150.5

Table 3

Mixture Proportions

Mix	Mixture Proportions, lb/yd^3					Air-Entraining Agent oz/100 lb Cement
	Cement	Slag	Water	Fly Ash	Concrete Aggregate	
A01	667	0	267	994	2016	0.86
2	492	164	270	971	1983	1.42
3	536	179	300	933	1919	1.08
4	533	178	305	921	1908	0.99
5	749	0	297	940	1931	0.93
6	410	336	296	937	1923	1.86
7	409	335	295	934	1918	1.86
8	410	336	296	937	1922	1.86
9	750	0	299	940	1933	0.79
10	260	483	297	932	1917	2.44
11	262	489	302	920	1892	2.39
12	263	490	303	923	1898	2.39
13	661	0	264	1012	2016	1.20
14	665	0	266	1018	2028	1.20
15	751	0	301	944	1942	0.84
B01	555	0	272	1801	1969	0.82
2	413	138	271	1075	1958	1.10
3	417	139	272	1086	1977	0.99
4	390	130	255	1098	2040	0.99
5	539	0	271	1126	2063	0.76
6	308	253	280	1061	1987	1.30
7	308	252	279	1060	1985	1.30

(Continued)

Table 3 (Continued)

Mix	Mixture Proportions, lb/yd^3					Air-Entraining Agent oz/100 lb Cement
	Cement	Slag	Water	Fly Ash	Concrete Aggregate	
B08	309	253	281	1062	1988	1.30
9	565	0	282	1106	1996	1.00
10	196	363	280	1069	1977	1.69
11	197	366	282	1078	1963	1.53
12	199	369	284	1087	2010	1.53
13	530	0	265	1110	2028	1.05
14	528	0	264	1105	2019	1.05
15	558	0	279	1092	1973	1.05
C01	476	0	286	1159	2060	0.92
2	353	118	282	1136	2037	1.10
3	353	118	283	1139	2040	1.03
4	336	112	268	1084	2175	1.06
5	450	0	269	1095	2103	0.92
6	248	203	269	1096	2106	1.38
7	244	200	266	1081	2075	1.59
8	244	200	266	1082	2077	1.47
9	448	0	269	1091	2095	0.92
10	158	293	270	1076	2107	1.36
11	157	292	269	1072	2100	1.36
12	159	295	272	1084	2124	1.36
13	458	0	275	1115	2141	0.92
14	459	0	276	1118	2147	0.92
15	452	0	271	1099	2112	0.92

(Continued)

Table 3 (Concluded)

Mix	Mixture Proportions, lb/yd^3					Air-Entraining Agent oz/100 lb Cement
	Cement	Slag	Water	Fly Ash	Concrete Aggregate	
1	563	0	282	1103	1993	0.81
2 AMI*	559	0	279	1094	1976	0.81
3 MI*	587	0	294	1150	2077	0
4	588	0	294	1151	2079	0
5 AME**	557	0	278	1091	1970	0.81
6 ME**	581	0	290	1137	2054	0

* High-range water-reducer "A" was added to mixes 2 AMI and 3 MI at the rate of 0.59 and 1.63 lb, respectively, per 100 lb of cement.
** High-range water-reducer "B" was added to mixes 5 AME and 6 ME at the rate of 2.78 and 2.29 lb, respectively, per 100 lb of cement.

Table 4

Sieve Analysis of Aggregates

Sieve Size	Percent Passing		
	Fine Aggregates	Coarse Aggregates	
1-1/2 in.	-	-	100.0 (95-100)
1 in.	-		40.3 (20-55)
3/4 in.	-	100.0 (85.100)	7.9 (0-15)
1/2 in.	-	59.0	-
3/8 in.	-	17.4 (0-20)	-
No. 4	98.4 (95-100)	0.4 (0-5)	-
No. 8	84.3 (80-100)	-	-
No. 16	73.C (50-85)	-	-
No. 30	43.6 (25-60)	-	-
No. 50	20.6 (10-30)	-	-
No. 100	7.1 (2-10)	-	-
No. 200	1.3	-	-
Pan	0	-	-

* The aggregates were specified as follows: nonreactive graded aggregates shall be used and shall be obtained from the Bay of Fundy area. Maximum size shall be 1-1/2 in., and aggregates shall meet the requirements of CSA A23.1.

Table 1-CR

Record of Testing of Concrete Prisms

Cement Replacement High-Range Water Reducers

(Installed October 1978)

Rack Row 8

1979- Readings

Prism No.	0 Cycles, 1979 %E	Pulse Veloc fps	%V²
A01	100	14,565	100
A02		13,825	
A03		14,085	
A05		14,250	
A06		13,760	
A07		13,760	
A09		14,285	
A10		13,955	
A11		14,285	
A13		14,425	
B01		14,150	
B02		14,085	
B03		14,425	
B05		14,565	
B06		14,020	
B07		14,565	
B09		14,085	
B10		14,425	
B11		14,355	
B13		14,425	
C01		14,220	
C02		14,285	
C03		14,285	
C05		14,495	
C06		14,285	
C07		14,495	
C09		14,285	
C10		14,355	
C11		14,150	
C13		14,425	
1		14,285	
2		13,760	
3		14,925	
4		14,850	
5		14,085	
6		14,780	

Table 2-CR

Record of Testing of Concrete Cylinders (6 by 2 in.)

Cement Replacement--High-Range Water Reducers

Rack Row 9

1979- Readings

Cylinder No.	0 Cycles, 1979 Pulse Veloc fps	s_v^2
A01-3	*	100
-4	*	
A02-3	12,500	
-4	13,700	
A03-3	14,285	
-4	14,285	
A04-8	13,890	
-9	13,890	
A05-3	13,890	
-4	13,700	
A06-3	14,285	
-4	13,700	
A07-3	13,700	
-4	13,890	
A08-14	13,700	
-16	13,700	
A09-3	14,285	
-4	14,495	
A10-3	14,285	
-4	14,285	
A11-3	14,285	
-4	13,890	
A12-11	13,890	
-13	14,085	
A13-3	14,705	
-4	14,705	
A1 -7	14,285	
-12	14,705	
A15-8	14,285	
-9	14,925	
B01-3	14,285	
-4	14,285	
B02-3	14,085	
-4	14,285	
B03-3	13,890	
-4	13,890	
B04-5	14,285	
-15	14,705	
B05-3	14,495	
-4	14,705	
B06-3	14,925	
-4	14,085	
B07-3	14,705	
-4	14,495	
B08-6	14,925	
-9	15,150	
B09-3	14,085	
-4	14,705	
B10-3	14,495	
-4	14,495	
B11-3	14,925	
-4	14,495	
B12-7	14,925	
-12	14,285	
B13-3	14,705	
-4	14,925	
B14-11	14,705	
-15	14,495	
B15-8	14,285	
-9	14,285	
C01-3	14,085	
-4	14,705	
C02-3	14,285	
-4	14,285	
C03-3	14,235	
-4	14,495	
C04-9	14,085	
-15	14,495	
C05-3	14,705	
-4	14,705	

(Continued)

* Specimens missing.

Table 2-CR (Concluded)

Rack Row 9

1979- Readings

Cylinder No.	0 Cycles, 1979 Pulse Veloc fps	Σv^2
C06-3	14,925	100
-4	14,285	
C07-3	14,495	
-4	14,495	
C08-6	14,495	
-16	14,705	
C09-3	14,495	
-4	14,495	
C10-3	14,495	
-4	14,495	
C11-3	14,085	
-4	14,085	
C12-10	13,890	
-14	11,765	
C13-3	14,085	
-4	14,085	
C14-13	14,925	
-14	14,495	
C15-9	14,285	
-8	14,085	
1-3	14,495	
1-4	14,085	
2AMI-4	13,890	
-3	14,085	
3MI-3	14,285	
-4	14,085	
4-3	14,925	
4-4	14,495	
5AME-3	14,085	
-4	14,085	
6ME-3	14,705	
-4	14,085	

Exposure Rack, Row 4 (W to E)

Specimen No.	Water Cement Ratio (by wt)	Air %	1978- Readings: 4794 Cycles 1978 %E	4794 Cycles 1978 $\%V^2$	4887 Cycles 1979 %E	4887 Cycles 1979 $\%V^2$
			Exterior, Nominal 4-bag-per-cu-yd Cement Factor			
Con-5-24(2)	0.49	4.1	101	NR	63	NR
			Interior, Nominal 3-bag-per-cu-yd Cement Factor			
Con-8-3A	0.59	4.6	68	NR	NR	NR
Con-12-8(2)	0.59	3.3	66	NR	78	NR

NR denotes that a satisfactory reading was not obtained although an attempt was made to obtain a satisfactory reading.

(Revised August 1980)

Table 1-CRA (Continued)

Section 25
Exposure Rack, Row 2 (W to E)

Specimen No.	Type Specimen	Cement Factor (Nominal) bags/cu yd	Air %	1972-3602 Cycles 1972 %E	1972-3602 Cycles 1972 %V²	3742 Cycles 1973 %E	3742 Cycles 1973 %V²	3878 Cycles 1974 %E	3878 Cycles 1974 %V²	3990 Cycles 1975 %E	3990 Cycles 1975 %V²	Readings 4136 Cycles 1976 %E	4136 Cycles 1976 %V²	4213 Cycles 1977 %E	4213 Cycles 1977 %V²	4360 Cycles 1978 %E	4360 Cycles 1978 %V²	4453 Cycles 1979 %E	4453 Cycles 1979 %V²
Admixture A																			
AC5B	Column	5.25	1.9	159	--	244	—	172	—	179	—	163	--	166	--	176	—	169	—
AB5C	Beam			93	--	143	--	128	—	Gone									
AC4	Column	4.5	2.0	165	--	171	--	272	—	Failed									
Paraffin Oil																			
OC5A	Column	5.25	3.9	101	--	94	—	96	—	96	—	Gone							
OB5A	Beam			120	--	119	--	117	—	112	—	119	--	101	--	101	--	161	—
OC5B	Column			F†	--														
OB5B	Beam			120	--	147	--	186	—	Failed									
OC5C	Column			79	--	72	—	NR	—	Gone									
OB5C	Beam			62	--	58	—	52	—	51	--	Gone							
OC6	Column	6.0	5.6	164	--	155	--	NR	—	Gone									
OB6	Beam			111	--	102	—	100	—	Failed									
Admixture B																			
ZC5A	Column	5.25	4.9	121	--	121	—	119	—	114	—	Failed							
ZB5A	Beam			104	--	176	—	NR	—	Gone									
ZB5B	Beam			85	--	91	—	172	—	Failed									
ZC5C	Column			100	--	215	—	215	—	Failed									
ZB5C	Beam			184	--	102	—	209	—	Failed									
ZC6	Column	6.0	6.0	91	--	126	—	95	—	75	—	Gone							
ZB6				112	--	112	—	78	—	114	—	82	--	Failed					
Rerin Soap + $CaCl_2$																			
CC5A	Column	5.25	7.8	F	--					Gone									
CB5A	Beam			85	--	62	—	NR	—	Gone									
CC5B	Column			F	--														
CB5B	Beam			F	--														
Resin Soap																			
RC5A	Column	5.25	6.5	116	--	116	—	111	—	113	—	Gone							
RC5A1	Column			114	--	119	—	NR	—	Gone									
RB5A1	Beam			122	--	120	—	120	—	122	—	Gone							
RB5C	Beam			97	--	88	—	119	—	119	—	117	--	108	—	135	—	122	—
Tallow (Beef)																			
TB5C	Beam	5.25	4.0	F	--														
TB6	Beam	6.0	3.6	83	--	NR	—	F	--										
Admixture C																			
DC5A	Column	5.25	6.5	105	--	105	—	96	—	87	—	118	--	135	—				
DB5A	Beam			107	--	112	—	105	—	105	—	78	--	98	—				
DC5B	Column			106	--	92	—	182	—	182	—	Gone							
DB5B	Beam			96	--	92	—	132	—	Failed									
DC5C	Column			F	--														
DB5C	Beam			72	--	F													
DC6	Column	6.0	6.1	88		122	—	153	—	Failed									
DB6	Beam			95		80	—	157	—	Gone									
Admixture D																			
HC5A	Column	5.25	8.0	105	--	94	—	103	—	99	—	95	--	130	--	133	—	162	—
HB5A	Beam			116	--	114	—	114	—	112	—	79	--	79	—	73	—	127	—
HC5B	Column			120	--	128	—	123	—	118	—	133	--	78	—	76	—	70	—
HB5B	Beam			117	--	124	—	114	—	116	—	114	--	126	--	123	--	118	—
HC5C	Column			252	--	252	—	234	—	Failed									
HB5C	Beam			79	--	68	—	NR	—	Gone									
HC6	Column	6.0	6.0	95	--	98	—	96	—	90	—	116	--	116	—	160	—	NR	—
HB6	Beam			96	--	138	--	90	—	90	—	67	--	Failed					

-- Dashed lines in "$\%V^2$" column indicate that end of specimen was too rough to obtain satisfactory reading.
† F denotes specimen has failed.
NR Denotes no reading obtained.

(Revised August 1980)

Table 1-OD

Section 26

Record of Testing of Concrete Beams, Omaha District Aggregate Program

1956- (Installed December 1956)

Exposure Rack, Row 2 (W to E)

Beam No.	Fine Aggregate	Coarse Aggregate	Type Cement	Air %	Cement Factor bags/cu yd	1956-1962 Readings: 0 Cycles 1956 %E	124 Cycles, 1957 %E	124 Cycles, 1957 Pulse Veloc fps	124 Cycles, 1957 %V²	195 Cycles 1958 %E	195 Cycles 1958 %V²	345 Cycles 1959 %E	345 Cycles 1959 %V²	416 Cycles 1960 %E	416 Cycles 1960 %V²	557 Cycles 1961 %E	557 Cycles 1961 %V²	646 Cycles 1962 %E	646 Cycles 1962 %V²
Oahe-1	Natural sand	Limestone A*	II, low-alk	6.1	5.32	100	116	15,245	100	117	108	123	98	121	100	121	102	115	105
Oahe-2				6.7	5.29	100	110	14,880	100	116	109	122	101	120	105	119	108	113	112
Oahe-3				6.6	5.30	100	111	15,245	100	116	106	123	98	119	102	118	108	113	113
S-G-1	Sand-gravel	Limestone B**	I	7.1	5.81	100	106	15,430	100	108	107	113	103	110	103	106	105	90	104
S-G-2				6.4	5.86	100	103	15,530	100	106	105	111	101	102	98	74	93	Ft	--
S-G-3				6.3	5.86	100	104	15,625	100	108	105	114	101	111	102	103	101	79	--

Beam No.	Fine Aggregate	Coarse Aggregate	Type Cement	Air %	Cement Factor bags/cu yd	1963-1969 Readings: 752 Cycles 1963 %E	752 Cycles 1963 %V²	887 Cycles 1964 %E	887 Cycles 1964 %V²	1050 Cycles 1965 %E	1050 Cycles 1965 %V²	1180 Cycles 1966 %E	1180 Cycles 1966 %V²	1336 Cycles 1967 %E	1336 Cycles 1967 %V²	1521 Cycles 1968 %E	1521 Cycles 1968 %V²	1675 Cycles 1969 %E	1675 Cycles 1969 %V²
Oahe-1	Natural sand	Limestone A*	II, low-alk	6.1	5.32	116	100	114	105	109	111	111	103	109	105	107	98	107	92
Oahe-2				6.7	5.29	114	118	112	110	107	112	109	102	104	109	106	100	108	95
Oahe-3				6.6	5.30	113	108	108	100	105	94	106	101	104	104	102	101	104	95
S-G-1	Sand-gravel	Limestone B**	I	7.1	5.81	41F	61												
S-G-3				6.3	5.86	F													

Beam No.	Fine Aggregate	Coarse Aggregate	Type Cement	Air %	Cement Factor bags/cu yd	1970-1976 Readings: 1828 Cycles 1970 %E	1828 Cycles 1970 %V²	1997 Cycles 1971 %E	1997 Cycles 1971 %V²	2154 Cycles 1972 %E	2154 Cycles 1972 %V²	2294 Cycles 1973 %E	2294 Cycles 1973 %V²	2430 Cycles 1974 %E	2430 Cycles 1974 %V²	2542 Cycles 1975 %E	2542 Cycles 1975 %V²	2688 Cycles 1976 %E	2688 Cycles 1976 %V²
Oahe-1	Natural sand	Limestone A*	II, low-alk	6.1	5.32	105	90	103	74	101	82	95	94	85	94	83	113	91	96
Oahe-2				6.7	5.29	103	94	103	78	96	82	98	87	84	95	82	114	82	86
Oahe-3				6.6	5.30	100	93	100	74	96	79	98	93	82	93	82	115	80	88

Beam No.	Fine Aggregate	Coarse Aggregate	Type Cement	Air %	Cement Factor bags/cu yd	1977- Readings: 2765 Cycles 1977 %E	2765 Cycles 1977 %V²	2912 Cycles 1978 %E	2912 Cycles 1978 %V²	3005 Cycles 1979 %E	3005 Cycles 1979 %V²
Oahe-1	Natural sand	Limestone A*	II, low-alk	6.1	5.32	95	92	93	87	71	—
Oahe-2				6.7	5.29	76	92	92	83	71	--
Oahe-3				6.6	5.30	90	78	82	87	70	—

-- End of specimen too rough to obtain satisfactory reading.
* Maximum size aggregate = 1-1/2 in.; slump for this mix = 2-3/4 to 3 in.
** Maximum size aggregate = 1 in.; slump for this mix = 2 in.
† F denotes specimen has failed.

(Revised August 1980)

Table 1-KCD (Continued)

Section 27

Exposure Rack, Row 2 (W to E)

Beam No.	Mixture No.	Fine Aggregate	Coarse Aggregate	Cement Factor bags/cu yd	1972-1979 Readings													
					2002 Cycles 1972		2142 Cycles 1973		2278 Cycles 1974		2390 Cycles 1975		2536 Cycles 1976		2613 Cycles 1977		2670 Cycles 1978		2763 Cycles 1979	
					%E	$\%V^2$	%E	$\%V^2$	%E	$\%V^2$	%E	$\%V^2$	%E	$\%V^2$	%E	$\%V^2$	%E	$\%V^2$	%E	$\%V^2$
KC-5-1	5	Sand B	Limestone	5.16	96	66	98	79	94	82	88	70	92	*	84		84	*	82	*
KC-5-2			D	5.14	NR†	79	88	87	88	81	84	66	78	*	76		80	*	96	*
KC-5-3				5.15	74	65	93	83	93	90	93	107	85	*	81		81	*	91	*
KC-6-1	6	Sand C	Limestone	5.84	95	87	101	94	93	98	97	121	89	96	89	91	89	93	89	*
KC-6-2			D	5.83	89	78	91	90	89	93	89	75	85	94	85	80	81	88	75	*
KC-6-3				5.81	96	79	96	98	92	93	90	77	88	95	86	92	84	93	84	*

† NR denotes a satisfactory reading was not obtained as specimen would not respond to flexural vibration.

* End of specimen too rough to obtain reading. $\%V^2$ data discontinued.

(Revised August 1980)

Table 2-KCD (Continued)

Section 27

Exposure Rack, Row 2 (W to E)

Beam No.	Mixture No.	Fine Aggregate	Coarse Aggregate	Cement Factor bags/cu yd	1972-1978 Readings: 1809 Cycles 1972		1949 Cycles 1973		2085 Cycles 1974		2197 Cycles 1975		2343 Cycles 1976		2420 Cycles 1977		2567 Cycles 1978	
					%E	$\%V^2$	%E	$\%V^2$	%E	$\%V^2$	%E	$\%V^2$	%E	$\%V^2$	%E	$\%V^2$	%E	$\%V^2$
KC-8-1	8	Sand BB	Limestone F	5.44	99	79	101	104	95	91	95	117	93	87	83	72	72	67
KC-8-2				5.44	NR††	55	NR	94	Failed									
KC-8-3				5.47	NR	68	NR	79	Failed									

Beam No.	Mixture No.	Fine Aggregate	Coarse Aggregate	Cement Factor bags/cu yd	1979- Readings: 2660 Cycles 1979	
					%E	$\%V^2$
AC-8-1	8	Sand BB	Limestone F	5.44	63	#

†† Satisfactory reading not obtained due to deteriorated condition of specimen.

End of specimen too rough to obtain reading. $\%V^2$ data discontinued.

(Sheet 2)

(Revised August 1980)

Table 3-KCD Section 27

Mixture Data and Record of Testing of Concrete Beams, Kansas City District Aggregate Program

1962- (Installed November 1962)

Exposure Rack, Row 2 (W to E)

Beam No.	Mixture No.	Fine Aggregate	Coarse Aggregate	Cement Replacement Material	Cement Factor bags/cu yd	1962-1967 Readings: 0 Cycles, 1962 %E	0 Cycles, 1962 Pulse Velocity fps	0 Cycles, 1962 %V²	106 Cycles 1963 %E	106 Cycles 1963 %V²	241 Cycles 1964 %E	241 Cycles 1964 %V²	404 Cycles 1965 %E	404 Cycles 1965 %V²	534 Cycles 1966 %E	534 Cycles 1966 %V²	690 Cycles 1967 %E	690 Cycles 1967 %V²
KC-13-1	13	Sand E	Limestone	None	5.47	100	15,150	100	117	101	102	100	102	110	100	101	94	104
KC-13-2			F		5.44	100	14,795	100	103	102	103	105	104	116	100	100	100	105
KC-13-3					5.46	100	15,150	100	103	102	103	99	101	112	99	95	93	104
KC-14-1	14	Sand E	Limestone	Fly ash*	5.13	100	14,535	100	102	104	102	104	103	130	101	98	101	105
KC-14-2			F		5.16	100	14,705	100	104	100	104	107	102	116	104	101	102	102
KC-14-3					5.13	100	14,535	100	104	105	102	102	100	109	98	98	98	106
KC-15-1	15	Sand E	Limestone	None	5.37	100	15,060	100	103	98	101	95	99	90	99	93	95	95
KC-15-2			C		5.36	100	15,060	100	102	105	101	95	97	101	99	93	91	95
KC-15-3					5.38	100	15,150	100	103	104	101	95	100	100	100	86	100	92

Beam No.	Mixture No.	Fine Aggregate	Coarse Aggregate	Cement Replacement Material	Cement Factor bags/cu yd	1968-1973 Readings: 875 Cycles 1968 %E	875 Cycles 1968 %V²	1029 Cycles 1969 %E	1029 Cycles 1969 %V²	1182 Cycles 1970 %E	1182 Cycles 1970 %V²	1351 Cycles 1971 %E	1351 Cycles 1971 %V²	1508 Cycles 1972 %E	1508 Cycles 1972 %V²	1645 Cycles 1973 %E	1645 Cycles 1973 %V²
KC-13-1	13	Sand E	Limeston.	None	5.47	98	100	98	94	96	90	94	75	82	87	88	101
KC-13-2			F		5.44	97	104	100	98	96	95	95	86	92	93	90	106
KC-13-3					5.46	97	100	99	94	97	90	96	75	89	75	93	87
KC-14-1	14	Sand E	Limestone	Fly ash*	5.13	101	107	99	102	97	99	97	74	101	86	101	88
KC-14-2			F		5.16	102	105	102	99	102	97	101	72	89	88	106	80
KC-14-3					5.13	100	105	98	99	98	95	106	68	100	--	122	86
KC-15-1	15	Sand "	Limestone	None	5.37	93	98	91	87	93	84	101	56	103	77	76	81
KC-15-2			C		5.36	80	85	80	76	84	75	F**					
KC-15-3					5.38	84	81	84	70	82	68	85	--	84	--	F	F

Beam No.	Mixture No.	Fine Aggregate	Coarse Aggregate	Cement Replacement Material	Cement Factor bags/cu yd	1974- Readings: 1784 Cycles 1974 %E	1784 Cycles 1974 %V²	1896 Cycles 1975 %E	1896 Cycles 1975 %V²	2042 Cycles 1976 %E	2042 Cycles 1976 %V²	2119 Cycles 1977 %E	2119 Cycles 1977 %V²	2266 Cycles 1978 %E	2266 Cycles 1978 %V²	2359 Cycles 1979 %E	2359 Cycles 1979 %V²
KC-13-1	13	Sand E	Limestone	None	5.47	82	101	84	116	84	96	82	86	84	89	78	†
KC-13-2			F		5.44	88	104	84	122	88	98	84	90	88	95	81	†
KC-13-3					5.46	91	82	85	123	87	90	87	92	95	96	87	†
KC-14-1	14	Sand E	Limestone	Fly ash*	5.13	68	85	50	65	NR	NR	Failed					
KC-14-2			F		5.16	100	82	71	101	67	NR	Failed					
KC-14-3					5.13	113	80	Failed									
KC-15-1	15	Sand E	Limestone	None	5.37	63	76	Failed									
			C														

* Fly ash content, 25 percent replacement by volume.
** F denotes specimen has failed.
-- Dashed lines in "%V²" indicate that end of specimen was too rough to obtain satisfactory reading.
NR Denotes no satisfactory reading was obtained.
† End of specimen too rough to obtain reading. %V² data discontinued.

(Revised August 1980)

Table 4-KCD

Mixture Data and Record of Testing of Concrete Beams, Kansas City District Aggregate Program

1963- (Installed December 1963)

Exposure Rack, Row 2 (W to E)

Beam No.	Mixture No.	Cement	Replacement Material	Fine Aggregate	Coarse Aggregate	Cement Factor bags/cu yd	1963-1967 Readings: 0 Cycles, 1963 Pulse Veloc fps	0 Cycles, 1963 $\%V^2$	121 Cycles 1964 $\%E$	121 Cycles 1964 $\%V^2$	284 Cycles 1965 $\%E$	284 Cycles 1965 $\%V^2$	414 Cycles 1966 $\%E$	414 Cycles 1966 $\%V^2$	570 Cycles 1967 $\%E$	570 Cycles 1967 $\%V^2$
KC-16-1	16	A	Fly ash*	Sand E	Limestone	6.25	14,535	100	104	105	104	98	106	104	105	122
KC-16-2					F	6.27	14,705	100	104	105	105	95	103	105	103	114
KC-16-3						6.26	14,620	100	103	105	104	101	100	106	100	114
KC-17-1	17	B	None	Sand F	Gravel B	6.00	14,235	100	104	108	78	92	65	38	F	
KC-17-2						6.02	14,535	100	103	109	74	82	F			
KC-17-3						6.00	14,125	100	103	110	49F**	77				
KC-18-1	18	C	None	Sand G	Quartzite	5.73	14,705	100	102	107	100	100	102	111	102	117
KC-18-2						5.77	15,150	100	102	102	102	98	104	109	106	113
KC-18-3						5.74	15,060	100	102	100	104	98	104	108	104	115

Beam No.	Mixture No.	Cement	Replacement Material	Fine Aggregate	Coarse Aggregate	Cement Factor bags/cu yd	1968-1973 Readings: 755 Cycles 1968 $\%E$	755 Cycles 1968 $\%V^2$	909 Cycles 1969 $\%E$	909 Cycles 1969 $\%V^2$	1062 Cycles 1970 $\%E$	1062 Cycles 1970 $\%V^2$	1231 Cycles 1971 $\%E$	1231 Cycles 1971 $\%V^2$	1388 Cycles 1972 $\%E$	1388 Cycles 1972 $\%V^2$	1528 Cycles 1973 $\%E$	1528 Cycles 1973 $\%V^2$
KC-16-1	16	A	Fly ash*	Sand E	Limestone	6.25	104	114	108	107	106	104	108	87	104	95	100	99
KC-16-2					F	6.27	107	110	109	105	109	100	107	84	105	88	107	93
KC-16-3						6.26	104	111	108	105	106	101	NR†	88	108	95	104	88
KC-18-1	18	C	None	Sand G	Quartzite	5.73	102	116	106	107	106	105	104	84	100	84	98	80
KC-18-2						5.77	102	109	104	104	108	102	106	85	104	87	92	88
KC-18-3						5.74	104	109	106	99	110	108	107	81	83	90	100	76

Beam No.	Mixture No.	Cement	Replacement Material	Fine Aggregate	Coarse Aggregate	Cement Factor bags/cu yd	1974- Readings: 1664 Cycles 1974 $\%E$	1664 Cycles 1974 $\%V^2$	1776 Cycles 1975 $\%E$	1776 Cycles 1975 $\%V^2$	1922 Cycles 1976 $\%E$	1922 Cycles 1976 $\%V^2$	1999 Cycles 1977 $\%E$	1999 Cycles 1977 $\%V^2$	2146 Cycles 1978 $\%E$	2146 Cycles 1978 $\%V^2$	2239 Cycles 1979 $\%E$	2239 Cycles 1979 $\%V^2$
KC-16-1	16	A	Fly ash*	Sand E	Limestone	6.25	98	106	98	137	94	79	90	98	75	91	—	††
KC-16-2					F	6.27	109	65	109	130	105	100	109	100	131	106	117	††
KC-16-3						6.26	104	68	104	125	104	90	104	NR	150	NR	91	††
KC-18-1	18	C	None	Sand G	Quartzite	5.73	102	106	102	82	82	93	100	NR	NR	NR	F	F
KC-18-2						5.77	64	65	Failed									
KC-18-3						5.74	92	68	80	72	176	NR	Failed					

* Fly ash content, 25 percent replacement by volume.
** F denotes specimen has failed.
† NR denotes satisfactory reading was not obtained as specimen would not respond to flexural vibration.
†† End of specimen too rough to obtain reading. $\%V^2$ data discontinued.

(Revised August 1980)

Table 5-KCD

Section 27

Mixture Data and Record of Testing of Concrete Beams, Kansas City District Aggregate Program

1969- (Installed May 1969)

Exposure Rack, Row 2 (W to E)

Beam No.	Mixture No.	Batch No.*	Aggregates	Air Content %	Avg** 28-day Compressive Strength psi	1969-1972 Readings: Initial Laboratory Readings, 1969 Pulse Veloc fps		0 Cycles 1969		153 Cycles 1970		322 Cycles 1971		479 Cycles 1972	
						% E	% V^2	% E	% V^2	% E	% V^2	% E	% V^2	% E	% V^2
KC-19-1	19	1	Crushed limestone 1-1/2-in. max	4.9	3360	100	14,620	100	101	100	93	97	88	84	83	92
KC-19-2	19	2	Crushed limestone 1-1/2-in. max	5.0	3360	100	14,620	100	100	100	90	98	87	84	83	91
KC-19-3	19	3	Crushed limestone 1-1/2-in. max	4.7	3640	100	14,620	100	106	101	90	96	90	85	88	92

Beam No.	Mixture No.	Batch No.*	Aggregates	Air Content %	Avg** 28-day Compressive Strength psi	1973-1978 Readings: 619 Cycles 1973		755 Cycles 1974		867 Cycles 1975		1013 Cycles 1976		1090 Cycles 1977		1237 Cycles 1978	
						% E	% V^2	% E	% V^2	% E	% V^2	% E	% V^2	% E	% V^2	% E	% V^2
KC-19-1	19	1	Crushed limestone 1-1/2-in. max	4.9	3360	83	102	83	114	83	78	81	114	86	109	72	108
KC-19-2	19	2	Crushed limestone 1-1/2-in. max	5.0	3360	82	94	82	114	79	77	74	110	79	104	81	89
KC-19-3	19	3	Crushed limestone 1-1/2-in. max	4.7	3640	84	101	86	113	86	139	82	116	82	105	82	95

Beam No.	Mixture No.	Batch No.*	Aggregates	Air Content %	Avg** 28-day Compressive Strength psi	1979- Readings: 1330 Cycles 1979	
						% E	% V^2
KC-19-1	19	1	Crushed limestone 1-1/2-in. max	4.9	3360	60	89
KC-19-2	19	2	Crushed limestone 1-1/2-in. max	5.0	3360	79	66
KC-19-3	19	3	Crushed limestone 1-1/2-in. max	4.7	3640	79	76

* The water-cement ratio of all three batches was 5.39 gal/bag or 0.49 by weight.

** Average based on compressive strength of three 6- by 12-in. cylinders per batch.

(Revised August 1980)

Table 6-KCD

Section 27

Mixture Data and Record of Testing of Concrete Beams, Kansas City District Aggregate Program

1975- (Installed July 1974)

Beam No.	Mixture No.	Batch No.*	Aggregates	Air Content %	Avg** 28-day Compressive Strength psi	Exposure Rack, Row 2 (W to E) 1974-1978 Readings: Initial Laboratory Readings, 1974 ΣE	Pulse Veloc fps	Σv^2	...2 Cycles 1975 ΣE	Σv^2	258 Cycles 1976 ΣE	Σv^2	335 Cycles 197[illegible] ΣE	Σv^2	482 Cycles 1978 ΣE	Σv^2
KC-20-1	20	1	Crushed limestone 1-1/2-in. max	5.0	3360	100	14,265	100	102	134	104	117	106	109	104	108
KC-20-2	20	2	Crushed limestone 1-1/2-in. max	5.4	3280	100	14,370	100	107	129	105	107	110	101	110	106
KC-20-3	20	3	Crushed limestone 1-1/2-in. max	5.3	3260	100	14,285	100	106	131	108	115	113	102	111	106

Beam No.	Mixture No.	Batch No.*	Aggregates	Air Content %	Avg** 28-day Compressive Strength psi	1979- Readings: 575 Cycles 1979 ΣE	Σv^2
KC-20-1	20	1	Crushed limestone 1-1/2-in. max	5.0	3360	104	105
KC-20-2	20	2	Crushed limestone 1-1/2-in. max	5.4	3280	110	107
KC-20-3	20	3	Crushed limestone 1-1/2-in. max	5.3	3260	106	110

* The water-cement ratio of all three batches was 5.34 gal/cwt or 0.445 by wt.

** Average based on compressive strength of three 6- by 12-in. cylinders per batch.

(Revised August 1980)

Table 7-KCD

Section 27

Mixture Data and Record of Testing of Concrete Beams, Kansas City District Aggregate Program

1975- (Installed July 1974)

Exposure Rack, Row 2 (W to E)

Beam No.	Mixture No.	Batch No.*	Aggregates	Air Content %	Avg** 28-day Compressive Strength psi	Initial Laboratory Readings, 1974			1974- Readings: 112 Cycles 1975		258 Cycles 1976		335 Cycles 1977		48[illegible] Cycles 1978	
						%E	Pulse Veloc fps	$\%V^2$	%E	$\%V^2$	%E	$\%V^2$	%E	$\%V^2$	%E	$\%V^2$
KC-21-1	21	1	Crushed limestone 1-1/2-in. max	5.0	4600	100	14,795	100	102	134	106	114	104	104	106	106
KC-20-2	21	2	Crushed limestone 1-1/2-in. max	4.9	5150	100	14,620	100	101	132	107	114	109	106	105	106
KC-21-3	21	3	Crushed limestone 1-1/2-in. max	5.1	4930	100	14,535	100	102	139	106	116	106	105	121	110

Beam No.	Mixture No.	Batch No.*	Aggregates	Air Content %	Avg** 28-day Compressive Strength psi	1979- Readings: 575 Cycles 1979	
						%E	$\%V^2$
KC-21-1	21	1	Crushed limestone 1-1/2-in. max	5.0	4600	94	110
KC-20-2	21	2	Crushed limestone 1-1/2-in. max	4.9	5150	102	107
KC-21-3	21	3	Crushed limestone 1-1/2-in. max	5.1	4930	121	105

* The water-cement ratio of all three batches was 5.28 gal/cwt or 0.44 by wt.
** Average based on compressive strength of three 6- by 12-in. cylinders per batch.

(Revised August 1980)

Table 1-ED

Section 28

Mixture Data and Record of Testing of Concrete Cubes, Eufaula Dam Aggregate Study

1958- (Installed October 1958)

Beach Row 1 (W to E)

Cube No.	Coarse Aggregate Maximum Size in.	Coarse Aggregate Description	Air %	Water-Cement Ratio gal/bag	Theo Cement Factor bags/cu yd	1958-1965 Readings: 0 Cycles, 1958 Pulse Veloc fps	0 Cycles, 1958 fv^2	150 Cycles 1959 fv^2	220 Cycles 1960 fv^2	361 Cycles 1961 fv^2	451 Cycles 1962 fv^2	557 Cycles 1963 fv^2	692 Cycles 1964 fv^2	855 Cycles 1965 fv^2
1	6	Poor	5.4	4.97	4.0	14,450	100	95	101	96	100	102	110	113
2	6	Random	5.9	4.85	4.0	14,650	100	95	100	100	104	107	110	107
3	3	Random	5.7	5.30	4.0	14,075	100	95	103	99	102	108	111	112

Cube No.	1966-1973 Readings: 985 Cycles 1966 fv^2	1141 Cycles 1967 fv^2	1326 Cycles 1968 fv^2	1480 Cycles 1969 fv^2	1633 Cycles 1970 fv^2	1802 Cycles 1971 fv^2	1959 Cycles 1972 fv^2	2099 Cycles 1973 fv^2
1	90	112	105	96	94	85	84	*
2	92	107	110	99	94	89	82	*
3	97	114	109	100	96	97	95	*

Cube No.	1974- Readings: 2235 Cycles 1974 fv^2	2347 Cycles 1975 fv^2	2493 Cycles 1976 fv^2	2570 Cycles 1977 fv^2	2617 Cycles 1978 fv^2	2710 Cycles 1979 fv^2
1	94	88	92	97	92	61
2	115	109	108	93	106	70
3	109	99	96	93	103	71

* Equipment malfunctioned in 1973.

(Revised August 1980)

Table 1-MCP

Section 34

Record of Testing of Box Specimens, Membrane Curing Program

1959- (Installed June 1946)

Box No.	East Corner	West Corner	Admixture East	Admixture West	Cement	Curing Material East	Curing Material West	Form Lining	Condition of Specimens, 1959-1961: 13 Winters 1959 East	13 Winters 1959 West	14 Winters 1960 East	14 Winters 1960 West	15 Winters 1961 East	15 Winters 1961 West
1	GVRW	GW	Resin	None	A	Water	Water	T-and-G*	Excel**	Excel	Excel	Excel	Excel	Excel
2	GVRCCW	GVRAHW	Resin + CC	Resin + AH	A	Water	Water	T-and-G	Excel	Excel	Excel	Excel	Excel	Excel
3	GCCJW	GCCW	Resin soap + CC	CC	A	Water	Water	T-and-G	Excel	Excel	Excel	Excel	Excel	Excel
4	GJW		Resin soap	Resin soap	A	Water	Water	T-and-G	Excel	Excel	Excel	Excel	Excel	Excel
5	AC		None	None	B	Air	Air	T-and-G	Excel	Excel	Excel	Excel	Excel	Excel
6	CAC	CWC	None	None	B	Air	Water	Lining A	Excel	Excel	Excel	Excel	Excel	Excel
7	RAC	RWC	None	None	B	Air	Water	Lining B	Excel	Excel	Excel	Excel	Excel	Excel
8	AHAC		AH	AH	B	Air	Air	T-and-G	Sl ck†	Excel	Sl ck	Excel	Excel	Excel
9	B-3	B-1	None	None	B	HPB	RG	T-and-G	Excel	Excel	Excel	Excel	Excel	Excel
10	B-8	B-2	None	None	B	KC70	HPC	T-and-G	Excel	Excel	Excel	Excel	Excel	Excel
11	B-25	B-23	None	None	B	SF45W	CS45	T-and-G	Excel	Excel	Excel	Excel	Excel	Excel
12	B-24	B-29	None	None	B	SF45	DSA	T-and-G	Excel	Excel	Excel	Excel	Excel	Excel
13	B-17	B-28	None	None	B	AFMST	PENC	T-and-G	Excel	Excel	Excel	Excel	Excel	Excel
14	B-18	B-30	None	None	B	A1C	TFX199	T-and-G	Excel	Excel	Excel	Excel	Excel	Excel

Condition of Specimens, 1962-1972

	16 Winters 1962 East	16 Winters 1962 West	17 Winters 1963 East	17 Winters 1963 West	18 Winters 1964 East	18 Winters 1964 West	19 Winters 1965 East	19 Winters 1965 West	20 Winters 1966 East	20 Winters 1966 West	24 Winters 1970†† East	24 Winters 1970†† West	25 Winters 1971 East	25 Winters 1971 West	26 Winters 1972 East	26 Winters 1972 West
1	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
2	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
3	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
4	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
5	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
6	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
7	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
8	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
9	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
10	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
11	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
12	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
13	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
14	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel

Condition of Specimens, 1973-

	27 Winters 1975 East	27 Winters 1975 West	28 Winters 1974 East	28 Winters 1974 West	29 Winters 1975 East	29 Winters 1975 West	30 Winters 1976 East	30 Winters 1976 West	31 Winters 1977 East	31 Winters 1977 West	32 Winters 1978 East	32 Winters 1978 West	33 Winters 1979 East	33 Winters 1979 West
1	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
2	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
3	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
4	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
5	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
6	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
7	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
8	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
9	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
10	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
11	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
12	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
13	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel
14	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel	Excel

* Tongue-and-groove lumber.
** Excel denotes excellent.
† Sl ck denotes slight crack.
†† Condition of the specimens did not change from 1967 to 1971.

(Revised August 1980)

Table 2-QA

Record of Testing of Cubes Made for Quality Aggregate Investigation

1963 Installation (Installed December 1963)

Beach Row A-1 (W to E)

Cube No.	Date Made	Coarse Aggregate	Water-Cement Ratio (by Wt)	Air Content* %	Slump* in.	1963-1969 Readings: 0 Cycles 1963 Pulse Veloc fps	0 Cycles 1963 fv^2	121 Cycles 1964 fv^2	284 Cycles 1965 fv^2	414 Cycles 1966 fv^2	570 Cycles 1967 fv^2	755 Cycles 1968 fv^2	909 Cycles 1969 fv^2
Q-11	Aug 1962	Dolomite	0.5	4.8	1-1/2	15,565	100	102	119	117	88	89	73
Q-12	Aug 1962	Dolomite	0.8	4.9	1-1/2	14,870	100	112	110	122	51	Failed	
Q-13	July 1962	Natural gravel B	0.5	5.0	1-1/2	15,875	100	114	122	112	107	105	91
Q-14	Aug 1962	Natural gravel B	0.8	4.9	1-1/2	15,505	100	103	118	118	102	84	66
Q-15	Aug 1962	Gneiss	0.5	4.8	1-1/2	14,335	100	124	140	135	131	121	107
Q-16	Aug 1962	Gneiss	0.8	4.8	1-1/2	13,890	100	122	112	139	76	Failed	

Cube No.	Date Made	Coarse Aggregate	Water-Cement Ratio (by Wt)	Air Content* %	Slump* in.	1970-1976 Readings: 1062 Cycles 1970 fv^2	1231 Cycles 1971 fv^2	1388 Cycles 1972 fv^2	1528 Cycles 1973 fv^2	1664 Cycles 1974 fv^2	1776 Cycles 1975 fv^2	1922 Cycles 1976 fv^2
Q-11	Aug 1962	Dolomite	0.5	4.8	1-1/2	Failed						
Q-13	July 1962	Natural gravel B	0.5	5.0	1-1/2	81	80	90	††	118	105	94
Q-14	Aug 1962	Natural gravel B	0.8	4.9	1-1/2	†	Failed					
Q-15	Aug 1962	Gneiss	0.5	4.8	1-1/2	99	104	115	††	120	123	116

Cube No.	Date Made	Coarse Aggregate	Water-Cement Ratio (by Wt)	Air Content* %	Slump* in.	1977- Readings: 1999 Cycles 1977 fv^2	2146 Cycles 1978 fv^2	2239 Cycles 1979 fv^2
Q-13	July 1962	Natural gravel B	0.5	5.0	1-1/2	94	108	105
Q-15	Aug 1962	Gneiss	0.5	4.8	1-1/2	109	120	114

* Air content and slump of that portion of the concrete containing aggregate smaller than 1-1/2 in. in size.
† A satisfactory reading could not be taken because of the condition of the specimen.
†† Equipment malfunctioned in 1973.

Table 1-CAP (Continued)

Beach Row 2 (W to E)

Specimen and Mix No.	Date Made	Nominal Cement Factor bags/cu yd	Replacement Material	Actual Sand: Aggregate Ratio %	Max Size Coarse Aggregate in.	1970-1975 Readings: 1062 Cycles 1970 %V²	1231 Cycles 1971 %V²	1388 Cycles 1972 %V²	1528 Cycles 1973 %V²	1664 Cycles 1974 %V²	1776 Cycles 1975 %V²
2	Sept 1963	2.0	None	24	6	†	Failed				
4	Sept 1963	2.0	Fly ash	24	6	86	†	Failed			
5	Sept 1963	2.0	Shale	30	3	†	Failed				
6	Sept 1963	2.0	Shale	24	6	84	†	Failed			
7	Sept 1963	2.5	None	30	3	104	76	104	††	84	106
8	Sept 1963	2.5	None	23	6	87	NR	86	††	104	94
9	Sept 1963	2.5	Fly ash	30	3	Failed					
10	Sept 1963	2.5	Fly ash	23	6	80	NR	86	††	38	Failed
11	Oct 1963	2.5	Shale	30	3	88	NR	88	††	Failed	
12	Oct 1963	2.5	Shale	23	6	83	20	84	††	96	92
13	Oct 1963	3.0	None	29	3	100	NR	100	††	116	113
14	Oct 1963	3.0	None	22	6	89	34	91	††	84	71
15	Oct 1963	3.0	Fly ash	29	3	91	90	109	††	122	118
16	Oct 1963	3.0	Fly ash	22	6	89	74	94	††	107	106
·	Oct 1963	3.0	Shale	29	3	95	72	99	††	112	114
18	Oct 1963	3.0	Shale	22	6	91	80	102	††	108	108

Specimen and Mix No.	Date Made	Nominal Cement Factor bags/cu yd	Replacement Material	Actual Sand: Aggregate Ratio %	Max Size Coarse Aggregate in.	1976- Readings: 1922 Cycles 1976 %V²	1999 Cycles 1977 %V²	2146 Cycles 1978 %V²‡	2239 Cycles 1979 %V²‡
7	Sept 1963	2.5	None	30	3	Failed			
8	Sept 1963	2.5	None	23	6	83	Failed		
12	Oct 1963	2.5	Shale	23	6	67	Failed		
13	Oct 1963	3.0	None	29	3	101	95	103	106
14	Oct 1963	3.0	None	22	6	71	81	89	82
15	Oct 1963	3.0	Fly ash	29	3	115	103	106	84
16	Oct 1963	3.0	Fly ash	22	6	89	65	94	104
17	Oct 1963	3.0	Shale	29	3	86	47	86	88
18	Oct 1963	3.0	Shale	22	6	77	59	100	86

† End of prism too rough to obtain satisfactory reading.
†† Equipment malfunctioned in 1973.
NR Unable to obtain satisfactory reading, although an attempt was made to do so.
‡ These specimens are spalling badly causing erratic readings.

Table 1-MAWC (Continued)

Prism No.	Date Made	Type Cement	Replacement Material	Water-Cement Ratio gals/bag	Water-Cement Ratio by weight	Cement Factor bags/cu yd	2036 Cycles 1978 %	2129 Cycles 1979 %
Mix 1, Rd 1	Feb 1964	II	None	6.8	0.6	2.93	96	37
Rd 2	Aug 1964	II	None	6.8	0.6	2.93	108	76
Mix 2, Rd 1	May 1964	II	None	7.9	0.7	2.51	81	79
Rd 2	July 1964	II	None	7.9	0.7	2.51	98	97
Mix 7, Rd 1	Mar 1964	II	Fly ash	6.4	0.6	2.93	94	NR**
Rd 2	Aug 1964	II	Fly ash	6.4	0.6	2.93	93	56

** NR denotes that a satisfactory reading was not obtained although an attempt was made.

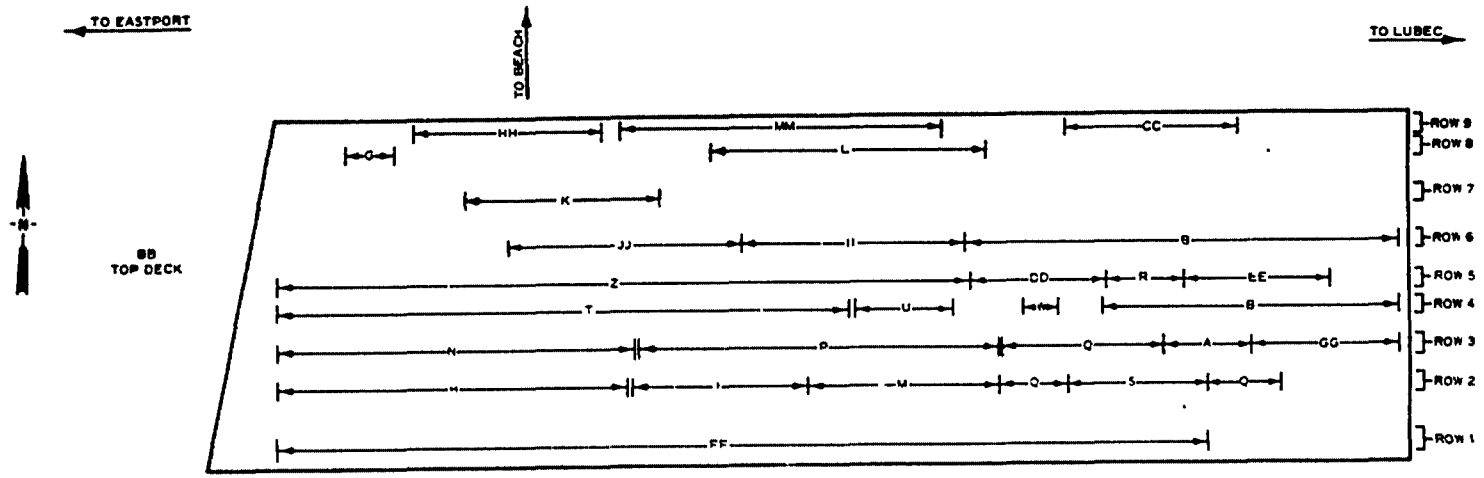
(Revised August 1980)

Table 1-CT (Continued)

Exposure Pack, Row 1

Prism No.	Position on Rack	Curing Condition	Type II Portland Cement %	Other Cement %	Other Replacement Material %	1167 Cycles 1976 %E	1167 Cycles 1976 $\%V^2$	1244 Cycles 1977 %E	1244 Cycles 1977 $\%V^2$	1391 Cycles 1978 %E	1391 Cycles 1978 $\%V^2$	1484 Cycles 1979 %E	1484 Cycles 1979 $\%V^2$
30021	10	1	100 (cement A)	None	None	99	99	99	98	96	97	80	83
30022	49					104	98	101	92	71	101	95	89
40021	14	2				109	91	105	70	101	82	105	NR
40022	44					93	98	101	68	100	100	100	98
50021	8	3				102	100	101	96	101	100	93	81
50022	31					108	102	110	109	110	99	105	98
60021	23	4				NR*	66	61	78	70	NR	NR	NR
60022	30					102	105	102	109	103	99	99	99
30421	40	1	100 (cement B)	None	None	86	85	101	24	103	80	55	62
30422	20					91	93	95	99	98	185	91	43
40421	15	2				96	96	88	92	86	81	81	75
40422	26					95	109	98	84	101	100	96	96
50421	28	3				84	86	83	Broken	Failed			
50422	6					98	98	95	102	97	98	89	90
60421	35	4				71	44	62	Broken	Failed			
60422	11					113	66	100	89	97	86	91	75
32581	18	1	75 (cement A)	None	25 (calcined shale)	97	75	96	75	96	38	82	NR
32582	1					108	104	106	83	103	74	119	88
42581	42	2				119	26	NR	NR	Failed			
42582	38					100	89	100	Broken	—	91	NR	47
52581	51	3			25 (shale)	Broken	61	NR	Broken	Failed			
52582	12					116	96	110	108	110	106	106	94
62581	27	4				75	NR	88	109	104	NR	NR	NR
62582	13					101	96	113	98	111	75	126	83
335N1	3	1	65 (cement A)	35 (nat cement)	None	110	82	84	72	82	54	68	NR
335N2	24					97	94	90	86	89	85	89	85
435N1	50	2				108	98	94	79	95	82	88	78
435N2	9					100	101	102	94	103	94	100	90
535N1	55	3				128	50	120	Broken	Failed			
535N2	39					124	NR	118	101	Failed			
635N1	4	4				Broken		Broken		Failed			
635N2	7					109		98		89	70	89	51
325F1	53	1	75 (cement A)	None	25 (fly ash)	101	81	90	81	93	95	86	35
325F2	45					106	97	105	100	106	99	100	91
425F1	56	2				84	96	80	95	80	84	75	80
425F2	25					116	99	112	96	113	94	108	100
525F1	17	3				112	103	104	105	105	102	102	101
525F2	29					107	100	104	80	107	90	101	NR
625F1	33	4				100	95	97	87	98	85	90	81
625F2	36					124	107	110	60	105	101	103	NR
3BFS1	41	1	None	100 (portland blast-furnace slag cement)	None	95	NR	69	84	76	NR	NR	NR
3BFS2	19					96	94	96	93	97	90	89	38
4BFS1	52	2				110	68	107	59	77	NR	NR	NR
4BFS2	21					110	92	99	90	102	90	94	84
5BFS1	16	3				99	72	84	68	82	NR	NR	NR
5BFS2	2					86	74	78	Broken	Failed			
6BFS1	5	4				97	41	71	Broken	Failed			
6BFS2	37					110	73	109	97	Failed			
335F1	22	1	65 (cement A)	None	35 (fly ash)	102	97	101	104	105	96	98	NR
335F2	54					109	85	102	69	100	93	100	85
435F1	46	2				92	97	93	93	90	86	87	83
435F2	48					105	83	94	89	94	89	121	NR
535F1	47	3				75	88	79	94	79	91	70	83
535F2	34					125	NR	123	97	Failed			
635F1	32	4				107	91	101	92	101	73	85	81
635F2	43					110	89	112	69	107	51	94	NR

* NR means no reading was obtained.



LEGEND

A	CERL FIBROUS CONCRETE (SECTION 5)
B	WES FIBROUS CONCRETE (SECTION 7)
G	PASSAMAQUODDY PROJECT (SECTION 9)
H	AIR-ENTRAINING ADMIXTURE STUDY (SECTION 25)
I	KANSAS CITY AGGREGATE PROGRAM (SECTION 27)
K	CONCRETE-POLYMER MATERIALS (SECTION 19)
L	CEMENT REPLACEMENT-HI-RANGE WATER REDUCERS (SECTION 20)
M	OMAHA DISTRICT AGGREGATE PROGRAM (SECTION 26)
N	LONG-TIME STUDY WES (SECTION 17)
P	PRESTRESS (PRETENSIONED) PROGRAM (SECTION 6)
T	CRMI-PHASE D (CORES) (SECTION 8)
U	MT. MORRIS DAM CORES (SECTION 22)
W	PINE FLAT DAM CORES (SECTION 5)
Z	PORTLAND BLAST-FURNACE SLAG CEMENT (SECTION 11)
BB	MEMBRANE CURING PROGRAM (SECTION 34)
CC	STEWART FIELD SPHERES (SECTION 3)
DD	MISSOURI RIVER DIVISION PROGRAM (SECTION 10)
EE	WOVEN PLASTIC TEST PROGRAM (SECTION 31)
FF	CURING INVESTIGATION (SECTION 39)
Q	SPECIMEN SIZE-FROST EFFECTS INVESTIGATION (SECTION 12)
R	INVESTIGATION OF PLASTIC BASED MORTAR COATINGS (SECTION 40)
S	INVESTIGATION OF 4-1 2-IN. AGGREGATE CONCRETE (SECTION 14)
GG	TRUMBULL POND DAM PRISMS (SECTION 13)
HH	SULFUR-INFILTRATED CONCRETE
II	ROLLER COMPACTED CONCRETE
JJ	CHARLES RIVER-SMELT BROOK (SECTION 18)
MM	CEMENT REPLACEMENT HI-RANGE WATER REDUCERS (SECTION 20)

ARRANGEMENT OF TEST SPECIMENS ON RACK

SEVERE-WEATHERING EXPOSURE STATION TREAT ISLAND, MAINE

AUGUST 1980

PLATE 2